THE

Tea Research Institute

OF

Ceylon.

BULLETIN No. 17.

Annual Report for the Year 1936.

IMPERIAL MYCOLOGICAL INSTITUTE
26 JUL 1937

Published by

THE TEA RESEARCH INSTITUTE OF CEYLON,
ST. COOMBS, TALAWAKELLE.

The Tea Research Institute of Ceylon.

BOARD OF CONTROL

(A) Representing the Planters' Association of Ceylon :—

(1) Mr. R. G. Coombe (Acting Chairman).

(2) Mr. Jas. Forbes (Jnr.), (on leave), Mr. Gordon Pyper (acting).

(3) Mr. J. D. Hoare.

(B) Representing the Ceylon Estates Proprietary Association :—

(4) Mr. D. T. Richards.

(5) Major J. W. Oldfield, M.C., C.M.G., O.B.E.

(6) Mr. I. L. Cameron (on leave) Mr. W. H. Attfield, (acting).

(C) Representing the Low-Country Products' Association :—

(7) Colonel T. G. W. Jayewardene, V.D.

(D) Representing the Small-Holders :—

(8) Mr. T. B. Panabokke.

(E) Ex-Officio Members :—

(9) The Hon. the Financial Secretary.

(10) The Director of Agriculture.

(11) The Chairman, Planters' Association of Ceylon.

(12) The Chairman, Ceylon Estates Proprietary Association.

Secretary, Roland V. Norris, D.Sc., St. Coombs, Talawakelle.

ELEVENTH ANNUAL REPORT

OF THE

BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON

FOR 1936.

Foundation.—The Tea Research Institute of Ceylon was established by Ordinance No. 12 of 1925, dated the 27th October, 1925.

Past Chairmen of the Institute.

Name	Date of Appointment	Date of Resignation.
Major J. W. Oldfield, C.M.G., O.B.E., M.C.	7th January, 1926	24th November, 1926
Mr. John Horsfall	24th November, 1926	14th April, 1927
Mr. R. G. Coombe	14th April, 1927	9th April, 1929
Major J. W. Oldfield, C.M.G., O.B.E., M.C.	9th April, 1929	30th September, 1929
Mr. C. Huntley-Wilkinson	30th September, 1929	28th November, 1929
Mr. R. G. Coombe	29th November, 1929	7th April, 1932
Mr. G. K. Stewart	7th April, 1932	26th November, 1932
Mr. R. G. Coombe	26th November, 1932	13th January, 1934
Mr. James Forbes (Jnr.)	13th January, 1934	

BOARD OF MANAGEMENT.

The Constitution of the Board is laid down in the Ordinance; the personnel on the 1st January, 1936, was :—

Ex-Officio Members.

The Hon'ble the Financial Secretary (Hon. Mr. H. J. Huxham).

The Director of Agriculture (Dr. J. C. Hutson, Acting Director).

The Chairman, Planters' Association of Ceylon (Mr. R. P. Gaddum).

The Chairman, Ceylon Estates Proprietary Association (Mr. E. L. Fraser).

Representatives of the Planters' Association of Ceylon.

Mr. James Forbes (Jnr.)
Mr. R. G. Coombe.
Mr. J. D. Hoare.

Representatives of the Ceylon Estates Proprietary Association.

Major J. W. Oldfield, C.M.G., O.B.E., M.C. (on leave), Mr. J. C. Kelly (acting).
Mr. I. L. Cameron.
Mr. D. T. Richards.

Representative of the Low-Country Products Association.

Col. T. G. Jayewardene, V.D.

Representative of the Small-Holders.

Mr. D. H. Kotalawala.

Chairman.—Mr. James Forbes (Jnr.)

Secretary.—Mr. A. W. L. Turner.

Solicitors.—Messrs. Julius & Creasy.

Auditors.—Messrs. Ford, Rhodes, Thornton & Co.

Registered Office.—The Victoria Commemoration Buildings, Kandy.

Chairman, T. R. I.—Mr. R. G. Coombe was elected to act as Chairman during the absence of Mr. James Forbes (Jnr.) on leave from the 28th October, 1936.

Members of the Board.—Major C. E. Hawes became an *ex-officio* member of the Board as from 7th August on succeeding Mr. E. L. Fraser as Chairman of the C. E. P. A.

Mr. I. L. Cameron, whose term of office as a representative of the C. E. P. A. expired in January, was renominated for a further period of three years from 28th January, 1936.

Mr. E. Rodrigo became an *ex-officio* member of the Board as from March 17th, 1936, on succeeding Dr. J. C. Hutson as Acting Director of Agriculture.

Mr. B. M. Selwyn was nominated by the Planters' Association of Ceylon to act for Mr. J. D. Hoare during the absence of the latter on leave from 15th April to 26th October.

Major J. W. Oldfield resumed his place on the Board on his return from leave in June, relieving Mr. J. C. Kelly.

Mr. A. G. D. Bagot was nominated by the Planters' Association to act for Mr. James Forbes (Jnr.) during the latter's absence on leave from 28th October.

Mr. D. H. Kotalawala resigned as from 27th October and a new nomination by His Excellency the Governor is awaited.

Secretary, T. R. I.—On the centralisation of administrative work of the Institute at St. Coombs, the Director of the Institute was appointed Secretary of the Board as from 1st April, 1936, relieving Mr. A. W. L. Turner.

AUDITORS.

Messrs. Ford, Rhodes, Thornton & Co. continued to act as the Institute's auditors.

MEETINGS OF THE BOARD.

Six meetings of the Board were held during the year, five in Colombo and one at St. Coombs.

COMMITTEES.

The following were the principal Committees in 1936 :—

Finance Committee.—The Chairman, T.R.I., the Chairman, C.E.P.A., the Chairman, Planters' Association of Ceylon, Major J. W. Oldfield, Mr. J. D. Hoare and the Director, T. R. I.

This Committee held three meetings.

Estate and Experimental Committee.—The Director, T. R. I. (Chairman), the Chairman, T.R.I., the Visiting Agent, the Superintendent, St. Coombs Estate, Messrs. R. G. Coombe, John Horsfall, D. T. Richards, R. H. Horne, I. L. Cameron, C. H. Wilkinson and the Agricultural Chemist (Convener).

Mr. I. L. Cameron resigned from the Committee on the 20th June and was succeeded by Mr. J. T. Young, while Messrs. L. C. A. Leefe and W. W. A. Phillips were nominated to act for Messrs. R. H. Horne and James Forbes (Jnr.) during the absence of the latter on leave.

This Committee held six meetings.

Medical Sub-Committee.—The Chairman, the Director, Major J. W. Oldfield and Mr. G. D. Austin.

Administration Sub-Committee.—The Chairman, Mr. I. L. Cameron and Mr. J. C. Kelly.

Committee for Allocation of Expenditure.—The Chairman, Messrs. R. P. Gaddum, J. C. Kelly and J. W. Ferguson.

Committee on Officers' Conditions of Service.—The Chairman, Mr. R. G. Coombe and Mr. D. T. Richards.

JUNIOR STAFF PROVIDENT FUND.

Mr. J. D. Hoare was nominated to act as Trustee of the Junior Staff Provident Fund during the absence of Mr. James Forbes (Jnr.) on furlough.

VISITING AGENT OF ST. COOMBS.

Mr. J. W. Ferguson continued as Visiting Agent during the year. In view of Mr. Ferguson's impending retirement, the Board at its meeting on the 19th December placed on record a most cordial vote of appreciation and thanks for the valuable services rendered to the Institute by Mr. Ferguson.

ADMINISTRATION OF THE INSTITUTE.

After very full consideration the Board decided to centralise the whole of the administration at St. Coombs under the Director of the Institute and to appoint the latter as the Secretary of the Board. The Director at the same time was made responsible to the Board for the administration of St. Coombs estate, acting in this connection in consultation with the Visiting Agent and the Estate and Experimental Committee.

The above changes became effective as from 31st March. The registered Headquarters of the Institute will, however, continue to be at the Victoria Commemoration Buildings, Kandy.

The above changes were considered necessary in the interests of administrative convenience and economy. The Institute will, however, continue as before to work in the closest co-operation with the Planters' Association of Ceylon, and gratefully acknowledges the support it has received from that body and the valuable services rendered to the Institute by Mr. Turner and Mr. Bisset.

The Bye-Laws of the Institute were revised during the year in order to give effect to the above administrative changes.

GOVERNMENT LOAN.

An application was made to Government during the year for reconsideration of the rate of interest payable on the Government Loan to the Institute which was fixed at 6 per cent. After consideration by the State Council the rate of interest was ultimately reduced to 5½ per cent with effect from 1st October, 1935.

ST. COOMBS ESTATE.

Considerable changes and improvements were carried out in St. Coombs factory during the year, designed to replace out-of-date plant and to permit of more hygienic methods of manufacture. Details will be found in the report of the Director.

Prices for Up-country tea were not too favourable during the year and the Colombo average for St. Coombs invoices was 79.3 cents. The

nett average worked out at 75.03 cents as compared to 76.93 cents in 1935. The slight falling-off may be explained by the large amount of young tea in plucking during 1936 and the poor prices prevailing for leaf grades during a large part of the year. A comparison between St. Coombs prices and the Colombo market average for high-grown teas is shown in the graph which accompanies this report.

The profit on estate working account was, however, Rs. 32,910 as against an estimate of Rs. 28,000.

A copy of Mr. Ferguson's review of the work done on the estate during the year is attached.

ESTATE SCHOOL.

The estate school was recognised by Government and a grant amounting to Rs. 282 was received.

SENIOR OFFICERS' CONDITIONS OF SERVICE.

A Sub-Committee was appointed by the Board during the year to review the conditions of service of the Senior Staff. As a result of their recommendations a revised form of standard agreement was drawn up and approved by the Board.

PUBLICATIONS.

The publications of the Institute are sent free of charge to all Proprietors, Directors, Superintendents and Assistant Superintendents of Ceylon Tea Estates of over 10 acres in extent, and to London and Colombo Agency Firms dealing in Tea, if they register their names and addresses with the Secretary, Tea Research Institute of Ceylon, St. Coombs, Talawakelle.

Other persons can obtain the publications of the Institute on payment to the Secretary, T. R. I., of a subscription of Rs. 15/- per annum if resident in Ceylon or India, and £1.5.0 if resident elsewhere. In the case of Indian cheques four annas should be added to cover commission.

Single numbers of *The Tea Quarterly* and Bulletins can be obtained at the rate of Rs. 2·50 or 4 shillings per copy.

During the year the following publications were issued :—

Bulletin No. 13 — Annual Report for 1935.

Bulletin No. 14 — Report on a Visit to the Tea Districts of North-East India by T. Eden.

Tea Quarterly, Vol. IX, Parts I-IV.

It is proposed to issue during the coming year a combined index to the publications so far issued.

The demand for the Institute's publications continues to increase and the income derived from outside subscriptions and from advertisements more than cover the cost of issue.

The following are now out of print :—

Bulletins Nos. 2, 3 and 5.

Tea Quarterly, Vol. I, Parts 1 to 4.
,, ,, ,, II, Parts 1, 2 and 3.
,, ,, ,, IV, Parts 1 and 2.
,, ,, ,, V, Part 1.

ACKNOWLEDGMENTS.

The thanks of the Institute are due to the Ceylon Chamber of Commerce, Colombo, for the use of their Board Room for meetings of the Institute held in Colombo.

Close co-operation has been maintained between the Institute, the Ceylon Estates Proprietary Association, the Ceylon Association in London, the Planters' Association of Ceylon and other bodies concerned in the tea industry.

FINANCE.

The Audited Statement of Accounts and Balance Sheet for 1936 are included at the end of this Report.

ROLAND V. NORRIS,
Secretary.

REPORT

ON

ST. COOMBS ESTATE

FOR 1936.

Superintendent.—Mr. John A. Rogers.

ACREAGE STATEMENT.

	A.	R.	P.
Tea in full bearing ...	226	0	11
New Clearings ...	38	0	35
Nurseries ...	3	0	25
Fuel Clearing ...	24	0	00
Reserve available for planting	63	1	09
Building sites ...	26	2	22
Waste ...	33	1	37
Total ...	414	3	19

Climate.—The weather conditions were so far as rainfall goes rather an improvement on 1934-35, but still not up to the average for this district over a period of 10 years. The rainfall for the year was 92.18 inches on 220 days as compared to 84.69 inches on 216 wet days in 1935.

Crop.—The crop secured in 1936 was 154,235 lbs. Made Tea.

,, ,, ,, in 1935 ,, 138,182 ,, ,,

Increase of 16,053 ,, ,,

The increase on the estimate of 150,000 lbs. was 4,325 lbs.

Yield per acre to 31st December, 1936 on 264 acres in plucking, 584 lbs.

Yield per acre to 31st December, 1935 on 246 acres in plucking, 562 lbs.

Sales.—Nett Average 1936. 75.03 cents.

,, 1935. 76.93 ,,

Cost of Production:—

31-12-36. 53.43 cents per lb. Estimate 57.23 cents.

31-12-35. 51.30 cents per lb. Estimate 57.56 cents.

Clearings.—There was no land opened during the year under review, but preparations have been made for the opening of 20 acres in 1937.

Cultivation—was carried out as estimated for. The tea all over the estate is in very good heart.

Nurseries.—The nurseries caused some anxiety early in the year, but the small application of artificial manure has worked wonders, and by June there will be a very good show of stumps ready for the new clearing. One maund of Kirimetiya tea seed and one of Chapelton were put down in the nurseries and have come away well.

Green Manures.—Much has been done to improve the supply of bush manures.

Swamps—are being rapidly converted into very valuable fuel blocks. The growth of the gum is most satisfactory.

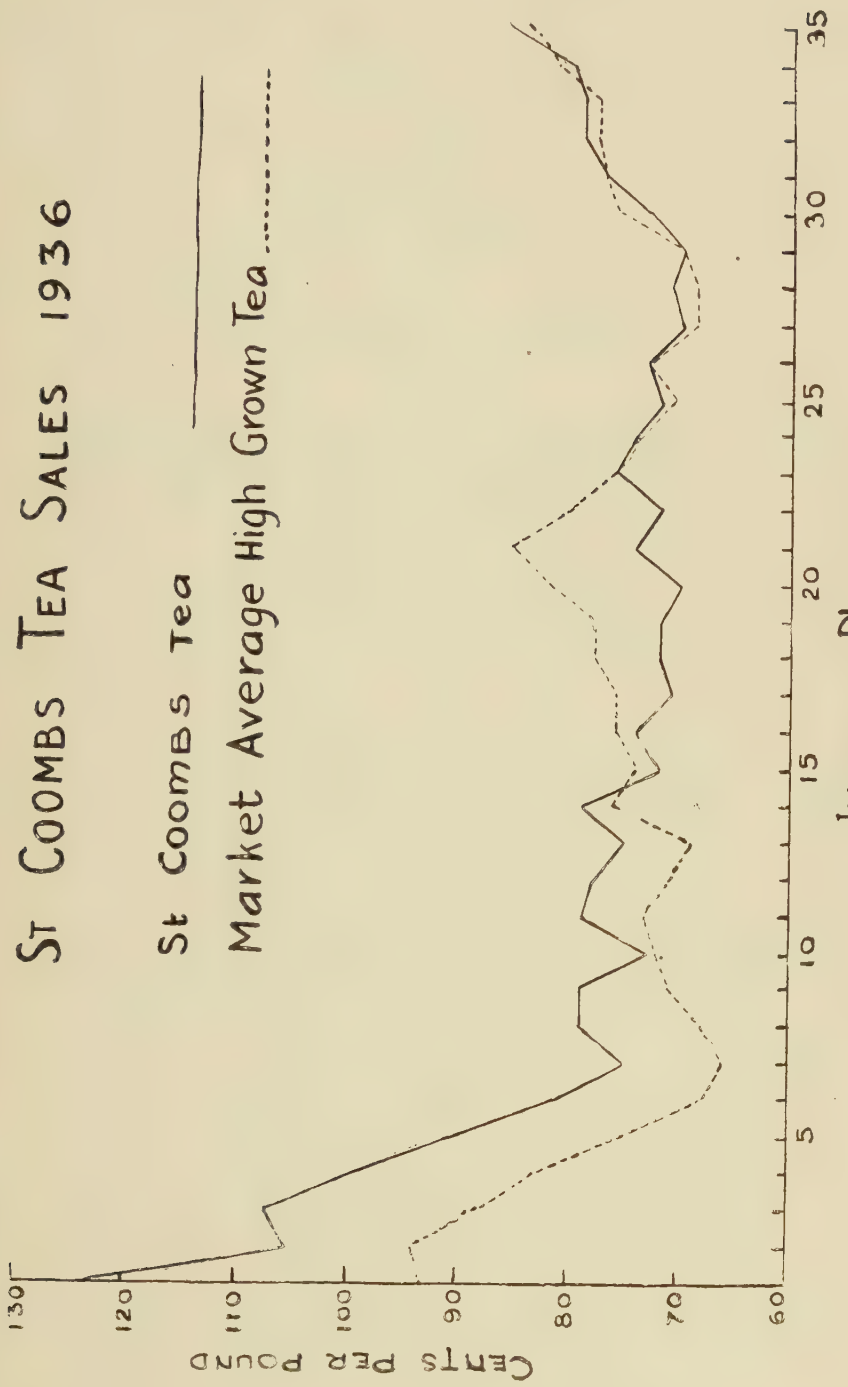
General.—Much good work has been done during the year under review, and the estate is in fine order. In the factory two new driers have been erected, and a green leaf cleaner and a refuse extractor installed. Special attention has been paid to factory hygiene.

(Sgd.) J. W. FERGUSON.

St. Clair,

Talawakelle.

6th March, 1937.


St Coombs Tea Sales 1936
St Coombs Tea
Market Average High Grown Tea
Cents per pound
130
120
110
100
90
80
70
60
5
10
15
20
25
30
35
Invoice Number

Meteorological Observations, 1936.

St. Coombs.

Month	Temperature				Mean Relative Humidity	Rainfall Inches	No. of Rainy days	Sunshine	
	Mean Min.	Mean Max.	Adopted Mean.	Mean on Grass				hrs.	mts.
January	75·2	53·3	64·2	46·8	64	3·16	10	226	51
February	77·4	55·1	66·2	49·3	72	3·24	8	251	07
March	76·4	56·1	66·2	51·6	74	5·60	14	198	57
April	79·6	56·5	68·0	52·0	74	0·61	5	233	24
May	73·2	59·8	66·5	56·7	87	21·60	23	94	48
June	72·2	59·5	65·8	57·1	83	6·59	23	124	37
July	69·8	60·1	65·0	59·4	90	15·05	29	76	27
August	71·0	59·2	65·1	59·4	88	4·46	26	140	36
September	73·0	57·9	65·4	57·5	86	12·69	27	117	15
October	74·9	57·8	66·4	55·4	81	5·56	19	202	27
November	73·5	58.1	65·8	54·6	78	5·29	20	144	17
December	74·1	58·3	66·2	52·1	74	8·97	16	160	05
Annual	74·2	57·6	65·9	54·3	79	92·82	220	1970	51
			Means				Total		

REPORT

OF

THE DIRECTOR,

TEA RESEARCH INSTITUTE OF CEYLON

FOR 1936.

Administration.—During the year important changes were made in the administrative organisation of the Institute. After long consideration it was decided to centralise the administration at St. Coombs under the Director of the Institute. In consequence, the arrangement formerly in force, by which part of the work was carried out in the Kandy Office of the Planters' Association of Ceylon, was terminated as from the 31st March. The change had become desirable on the grounds of administrative convenience, and the cost of administration has also been reduced by the new organisation.

The registered headquarters of the Institute, however, remain at Kandy and the close and cordial relations which have always existed between the Institute and the Planters' Association will of course be maintained.

Secondly, St. Coombs Estate has been placed under the administrative charge of the Director, implementing the frequently declared policy of the Board that the estate must be regarded not as a separate entity but as an integral part of the research organisation. Adequate safeguards have, however, been provided to ensure that the commercial aspects of the estate shall receive full consideration in order that as large an income as possible may be obained to supplement the general resources of the Institute. The estate is regularly inspected by a Visiting Agent who is directly responsible to the Board. Moreover, all matters of general estate policy, the annual estimates and all major experimental programmes are examined in detail by, and must receive the approval of, the Estate and Experimental Sub-Committee before they are submitted for the sanction of the Board, who alone can authorise new expenditure.

This committee consists of the Director, who is the Chairman, the Visiting Agent, the Superintendent of St. Coombs, a member of the Scientific Staff who acts as Secretary, three members of the Board, three

other planting members and a Colombo broker. The constitution of the committee is therefore a guarantee that the practical aspects of estate working will not be overlooked, and provides a very ample safeguard against any dissipation of the estate resources by the adoption of an insufficiently considered programme of work.

Finance.—The maintenance of the restriction figure at eighty-two-and-a-half per cent automatically reduces the income derived from the cess. In the past year, however, this was more than offset by unusually high exports in the earlier months due to the utilisation of the balance of coupons from the previous year. In consequence, the yield from the cess was Rs. 305,282 as compared with Rs. 298,492 in 1935 and Rs. 303,265 in 1934. Tea prices were slightly less satisfactory than in 1935 but the profit on estate working account amounted to Rs. 32,910 as against an estimate of Rs. 28,000.

With other miscellaneous items the gross receipts for the year amounted to Rs. 341,253, the figure for 1935 being Rs. 338,351.

Expenditure on Revenue Account was Rs. 199,862 as against Rs. 198,229 in 1935 and, after making provision of Rs. 34,801 for depreciation and meeting interest charges on the Government Loan amounting to Rs. 45,132, there was a surplus on the year's working of Rs. 61,110. The corresponding figure for 1935 was Rs. 53,315.

Research Capital Expenditure amounted to Rs. 13,802, the chief items being Rs. 4,602 on Experimental Machinery; Rs. 1,345 on the Passara Sub-Station; and Rs. 4,335 for the replacement of the motor-car.

Estate Capital Expenditure was Rs. 44,245, the most important item being Rs. 26,485 on account of new machinery and additions in St. Coombs factory. Further details in regard to this expenditure will be found later in this report.

Rs. 28,730 was repaid against the Government Loan, the balance outstanding being now Rs. 818,276. As a result of representations made to Government the rate of interest payable on the loan has now been reduced from 6 to 5½ per cent.

Co-operation in Tea Research.—Close contact has been maintained between the Institute and the corresponding research organisations in India and the Netherlands East Indies. In December Mr. P. H. Carpenter, the Chief Scientific Officer of the Tocklai Experimental Station, visited St. Coombs to discuss with the Director the respective programmes of work, and Dr. Hoedt, the Director of the Proefstation West Java, will be attending the Institute's conference to be held in January, 1937.

It was, unfortunately, not possible for Dr. Tubbs, the Institute's Plant Physiologist, to pay his projected visit to India but this will be done in 1937.

During the year a report of great interest in relation to research on tea was issued by a committee, under the chairmanship of Professor F. L. Engledow, which visited North-East India to review the working of the Tocklai Experimental Station. Though primarily concerned with the particular conditions of North India, this report gives an interesting summary of what the committee considered to be the major problems in tea research. Suggestions were also made as to the manner in which some of these problems might be approached and indications given of directions in which some division of work between the various research stations might be effected.

It is satisfactory to note after studying this report that the general research policy adopted at St. Coombs is on lines favoured by this committee. The various recommendations made are now being considered in collaboration with the Directors of the Tocklai and Java Stations and some further references to these will be found later in this report.

St. Coombs Estate.—The rainfall, 92.82 inches, was about normal and well distributed with the exception of April when only 0.61 inch was recorded. The crop obtained amounted to 154,235 pounds against an estimate of 150,000. Prices were not quite so favourable as in 1935, the average selling price in Colombo being 79.29 cents. The nett average realised was 75.03 cents, 1.9 cents lower than in the previous year. Quality was no doubt adversely affected by the large area of young tea brought into plucking but the chief reason for the lower average was the relatively poor prices prevailing during much of the year for leaf grades. The profit on estate working account was, however, nearly Rs. 5,000 above the estimate, amounting to Rs. 32,910.

Considerable progress was made in draining swamp areas and it has now been possible to put some 19 acres under gums. This policy will be extended as the supply of timber for fuel is at present very limited.

A 3½-ton Diesel motor roller was purchased during the year. When not required on St. Coombs this will be hired out to neighbouring estates.

In St. Coombs factory the two tilting tray driers were replaced by a 3 ft. Marshall Empire Drier and a short 3 ft. Sirocco E.C.P. Drier. The latter machine has been specially designed to meet the Institute's requirements and has a capacity of about 104 lbs. made tea per hour. It is understood this drier, which has several improved features, will shortly be available as a standard model. If so, an automatic machine of this capacity will form a useful addition to the range of driers at present available.

Other new commercial machinery installed includes a C.C.C. Multiple Green Leaf Sifter with Francillon type collecting trays, a sifter for cleaning withered leaf and a magnetic tea cleaning machine. Additions and alterations have also been made to much of the other plant to bring this up to date

and to provide for manufacture being carried out under the most hygienic conditions. In this connexion it may be mentioned that the Institute has been in close touch with the Ceylon Association in London and the Ceylon Estates Proprietary Association in regard to measures designed to improve still further general conditions of manufacture in Ceylon.

The experimental machinery has also received attention, details of which will be found later in this report.

Staff.—No changes occurred in the Senior Staff during the year.

Dr. Eden, Agricultural Chemist, proceeded on home leave on the 28th October, his advisory work being taken over by the Director, while Dr. Tubbs was placed in charge of field experiments.

Amongst the Junior Staff, Dr. J. G. Shrikhande, Research Assistant to the Agricultural Chemist was on sick leave from August until the end of the year.

Mr. H. B. Shreerangachar, M.Sc., B.Sc., A.I.I.Sc. was appointed as Research Assistant in the Department of Biochemistry.

Mr. J. W. Reith resigned his appointment as Field Assistant to the Plant Physiologist and was succeeded by Mr. F. P. Jayawardana.

Advisory Work.—There was a very marked increase in the amount of advisory work carried out for estates, the number of enquiries received rising from a little over 2,000 in 1935 to nearly 3,000 in 1936. At the same time the number of visits paid to estates by members of the staff rose from 150 to 200, the distances travelled by road alone amounting to nearly 15,000 miles.

The importance and extent of this work is not perhaps fully recognised. But it is largely by such means that the Institute must exercise its influence and there can be little doubt that the general advisory work of the Institute is having an increasing and cumulative effect on estate practice.

The fact that more and more use is being made of the Institute justifies us in assuming that the advice given has been of practical assistance. But the time is not far distant when it will have to be considered how much further this side of the Institute's activities can be developed without unduly encroaching on the time available for research.

The same difficulty has occurred in North-East India where the recruitment of separate advisory staff is under consideration.

Lectures.—There was again a considerable demand for lectures by the Staff and fourteen addresses were given to various District Planters' Associations.

In addition, the Director attended the meetings of the General Committee of the Planters' Association of Ceylon, the Board of Agriculture and occasional meetings of the Ceylon Estates Proprietary Association.

Publications.—In addition to *The Tea Quarterly* two Bulletins were issued during the year and two further Bulletins were sent to the press and will be issued early in 1937.

There was a wide demand for the Institute's publications and Rs. 3,975 was derived from the sale of these to persons not entitled to a free issue. A further income of Rs. 2,485 was obtained from advertisements with the result that after meeting the cost of printing and distribution there was a profit of rather over Rs. 1,500.

Diseases and Pests.—Enquiries in regard to diseases of tea have been rather more numerous than in recent years. It is probable however that this represents more interest in the question rather than any marked increase in the incidence of disease.

In recent reports attention has been called to the prevalence of Poria root disease and the inadequacy of the methods usually adopted for its eradication. The question has been the subject of very careful study at St. Coombs during the past two years and attention is invited to the report of the Mycologist where the methods now advocated by the Institute are summarised.

The procedure recommended, while initially more expensive than the measures now generally in use, if thoroughly carried out does offer a reasonable chance of eliminating the disease and must therefore in the end prove more economical.

Numerous cases of Brown Root disease have been reported. In areas where this occurs the importance of removing stumps of felled shade or jungle trees must be emphasised. Moreover the removal must be done immediately after felling.

A somewhat obscure new disease has been observed in one district. This is characterised by considerable distortion of the leaves which often become markedly curled. Later but few branches are found and the bushes become quite unproductive. Examination of the roots generally reveals small dead areas in the inner bark. No fungi or other organisms have as yet been detected in these lesions and hence the cause of the disease, to which the name *Phloem necrosis* has been applied, is at present unknown. Investigations are proceeding and a fuller account of the disease will be found in the report of the Mycologist.

Insect pests have not been unusually prevalent during 1936. Tortrix, in particular, was much less in evidence in the earlier part of the year

though later there were indications that this pest was likely to increase. The fact that Tortrix does little damage in Java, though it occurs there, suggested that possibly parasites could be found there capable of exercising some control. When the Director was in Java in the previous year this possibility was discussed, with the result that the Institute of Plant Diseases, Buitenzorg, kindly offered to co-operate in a search for such parasites. Since then a few consignments have been sent to us for trial. There is some evidence that one species at least may be able to establish itself here though it is yet too early to express a definite opinion.

Meantime the Entomologist has been investigating the results obtained with the modified system of eggmass collection indicated in the Annual Report for 1935. The very regular periodicity of attacks suggests that this system may be more efficacious and less costly than the routine collection at present carried out.

Work on termites in so far as tea estates are concerned has now been taken over by the Institute from the Department of Agriculture. Reports which come in of termite damage are sometimes somewhat misleading since confusion often exists through failure to distinguish between the work of scavenging termites which atack only diseased and dead wood and the true pests which devour the sound wood. For the latter, the Paris Green treatment is effective but some care is necessary in applying this, and those interested should refer to the Entomologist's remarks on this subject in his report.

Mosquito Blight, or Helopeltis, was rather more prevalent in the Morawak Korale than usual and an experiment was started on an estate in the Deniyaya area to see whether a method of combating this pest could be devised.

At the Passara Sub-Station work on Nettle Grub has been continued. This pest, however, was not prominent in 1936 and only seventeen estates in Uva were affected to any extent.

Systematic work on Shot-hole borer has also been taken up at Passara. Details will be found in Mr. King's report.

Agricultural Chemistry.—Manurial experiments have continued at the Passara Sub-Station as well as St. Coombs and the effect of nitrogen, potash and phosphoric acid have all been under consideration.

The nitrogen results remain the same, namely that at the level employed no significant differences in yield or quality have been found between the different forms of nitrogen used, *e.g.*, sulphate of ammonia, bloodmeal or groundnut cake. This result has now been obtained over a period of five years, so the conclusions reached may be accepted with confidence,

At St. Coombs the effect of the "no-potash" treatment is beginning to be noticeable. These particular plots have now received no potash for five years and, while this omission has had no influence on yield, indications are now appearing that it is detrimental to quality. At Passara where the experiment has not been running so long, no effect is yet visible. At St. Coombs there is also a small but significant decrease in yield when phosphate is continuously omitted.

The Institute has always been opposed to unbalanced manuring, *i.e.*, the omission of any one of three main plant foods, and these results show that this objection has been sound.

Reference was made to compost in the last annual report and the subject has been mentioned several times in the Institute's publications during the year and is dealt with in some detail in the report of the Agricultural Chemist. It is evident that there is still a good deal of misunderstanding as to the attitude of the Institute on this question. Many people apparently believe that the Institute regards compost as of no value, but for this there is not the slightest foundation. The value and importance of maintaining, and if possible increasing, the amount of organic matter in the soil has been continually stressed. The difference of opinion is therefore limited to the manner in which this can most economically be carried into effect.

The organic matter required must in the main be derived from two sources, (1) pruning leaf, green manures and loppings of shade trees, all materials which are normally incorporated in the soil under present practice or (2) waste materials which may be available on or near the estate and which very frequently will not be suitable for forking in without previous treatment.

It is for these latter materials that the various methods of composting are really intended and there is everything to be said for composting in such circumstances, provided the amount and situation of these waste materials is such as to permit of the process being done at a reasonable cost. But much more reliable figures are required as to the real cost of composting on the average Ceylon estate. Very few of the figures quoted include all the charges of collection and more often than not the cost of transporting the compost is completely ignored. To reduce the latter item it is becoming common to compost in small unprotected heaps alongside estate roads in positions convenient for distribution. Unfortunately, in the wetter districts this introduces another complication since there is ample evidence that by exposure to rain losses of nitrogen up to nearly 50 per cent may take place.

Experience in Ceylon over many years has shown that the materials in the first category, pruning leaf and loppings of green manures and shade trees have a carbon-nitrogen ratio which enables them to be safely

incorporated in the soil without previous composting. Unless therefore compost can be shown to confer advantages over an equivalent amount of fresh material there would appear to be no valid reason for incurring the extra expense of composting such substances. At present no evidence is available that such a benefit results.

In Ceylon a large proportion of the estates making compost are using in their raw material a high percentage of green manures or pruning leaf. It is this application of the composting process which the Institute considers in the present state of our knowledge to be unnecessary and uneconomical in normal circumstances.

It appears to us that composting should be restricted to true waste materials from which *additional* supplies of organic matter which would not otherwise be utilised can be made available for the tea. The question is then purely one of economics, and we would urge that more accurate figures should be obtained as to the real cost of the process including cost of collection of material and transport of the finished compost.

In regard to the practice of collecting all leaf-fall from the tea a word must also be said. It should not be overlooked that a mulch of this kind has very beneficial effects in conserving soil moisture during the dry season and that undue exposure of the bare soil is to be deprecated.

The Institute is itself making compost on a small scale from waste materials and is collaborating in an estate experiment when very large quantities have been manufactured. Data will therefore before long be available both in regard to costing figures and to the relative effect of equivalent applications of compost and green manures.

In the laboratory another side of the question is being investigated, namely the availability of the nitrogenous constituents of compost.

Soil Erosion.—Interest in the soil erosion problem was revived during the year as the result of a questionnaire sent out to estates by the Board of Agriculture. The views of the Institute were expressed in an article by the Director in *The Tea Quarterly* 1935, Vol. IX, Part IV, pages 133-144. Clean weeding, or rather the method by which this is usually achieved, namely scraping, is undoubtedly responsible for much of the erosion that occurs on estates. The Institute has advocated a more extensive trial of selective weeding and is conducting such a trial on St. Coombs, details of which will be found in Dr. Eden's report. From such trials it is hoped a wider selection of plants available as soil covers for the different tea areas may be obtained. Estates were asked to collaborate in such work and quite a satisfactory response has been made and a good deal of information sent in concerning species of weeds found, favourable or otherwise.

Much remains to be done and it is obvious that more intensive propaganda is required. In view of the fact that it is impossible for any of the Institute's Staff to devote more than a portion of his time to such work, it was noted with satisfaction that the Board of Agriculture recommended to Government the appointment of a whole-time officer for soil erosion investigation and propaganda. Unfortunately, at the time of writing, it seems rather unlikely that this recommendation will be adopted. In this connection it must be remembered that erosion is a problem by no means confined to estates and it cannot reasonably be expected that the various Research Institutes should take entire responsibility for the work required.

Physiological Work.—As a general account of the activities of the Physiological Section has just been published (Bulletin No. 15) reference will only be made here to more recent developments in the work of the Department. The Engledow Committee in their report, to which reference has already been made, stressed the importance to the tea industry of investigations on plant selection and methods of propagation of such selected material. The problem is a difficult one but the first stage must be to obtain some classification of our so-called jâts from which the process of selection can begin. North-East India is a favourable area for preliminary work of this kind since there is available there a much larger range of material and more defined jâts. The Tocklai Experimental Station has therefore concentrated on this aspect of the question.

Parallel with such work, investigations must be made in regard to the best and most economical method of propagation for any material selected. This will involve a study of the methods of vegetative propagation suitable for tea. In Java special attention has been paid to budgrafting but it is rather unlikely for several reasons that this will prove the method most suitable for Ceylon. Work on the vegetative propagation of tea has therefore been taken up at St. Coombs and promising results are already being obtained. The work at St. Coombs will therefore supplement that carried out at Tocklai and Buitenzorg, and unnecessary duplication of effort will be avoided.

Attention has also been paid to the question of the replanting of poor tea areas and of supplying, and a field experiment on this subject is in preparation. In replanting there is little doubt much improvement could be effected by a much more drastic process of nursery selection, only vigorous, heavy stumps being utilised. Though, initially, extra expenditure will be necessary this would prove economical in the long run.

The investigation must eventually cover a wide range as little reliable information is at present available in regard to the effect of ageing in tea or as to the period after which tea in different areas begins to deteriorate.

Tea Manufacture and Biochemistry.—Reference has already been made to the alterations and additions to the commercial plant. The experimental machinery has also received attention and the new small-scale drier has now been installed. This machine which has a capacity of about 20 lbs. per hour presents several interesting features. It is steam heated and capable of very accurate temperature control and can be used either as an up or down-draught machine. An experimental withering tunnel has also been constructed in order to obtain further information in regard to the effect of temperature and humidity on withering.

The standardisation of the small-scale rollers has enabled comparisons to be made between the results produced with different types of battens. The preliminary indications are discussed in Mr. Lamb's report.

Increase in the Staff of the Section has enabled interesting work on the enzymes or ferments of tea to be carried out. It has been clearly shown that the oxidising enzyme is by no means inactivated during normal firing, about 25 per cent of the fermenting power still remaining. Further changes in the tea must therefore be chiefly controlled by the moisture content which, as previously suggested, is thus the determining factor in the keeping properties of the tea. The importance of proper packing is therefore again emphasised. A considerable amount of work has continued on this question and several alternative forms of packing material have been under investigation. The most promising results have been obtained with a metal-coated paper. This is readily sealed and stands up well to transport conditions, besides being moisture-proof. Excellent reports have been obtained on a few small shipments and, though a few points still call for further examination, it is hoped it will shortly be possible to make a definite recommendation in regard to the use of such material.

Advisory work in this section has as usual been heavy, and once again enquiries concerning firing have been numerous. While the importance of packing teas with a sufficiently low moisture content must be stressed, there is a fair amount of evidence that teas are not infrequently dried out too far, *e.g.*, to a moisture content of 1 or 1½ per cent on leaving the drier. This may check the maturing of the tea and is also uneconomical. It is suggested that a lower figure than 3 per cent should be avoided.

One major difficulty in regard to research on tea manufacture is our lack of knowledge of the chemical constituents of tea — both green leaf and made tea. In such circumstances the value of the leaf cannot be assessed before manufacture, the chemical changes during manufacture cannot be followed with sufficiently accurate measurements and our judgment of the finished product cannot be expressed in analytical terms.

This difficulty is common to all the producing countries and a suggestion was made some time ago by the writer that work on the fundamental

chemistry of tea was a particularly suitable subject for co-operative effort. The Engledow Committee has strongly supported this point of view. They emphasise the difficulty of the subject which, in their opinion, could best be investigated in some scientific centre in Europe, the cost being shared by the producing-countries. The possibilities of such a scheme are receiving further consideration.

The question of the general conditions of manufacture has also received a great deal of attention during the past year, and the Institute, working in close contact with the Ceylon Association in London and the Ceylon Estates Proprietary Association, has taken an active part in propaganda to secure that the greatest possible attention shall be paid to the maintenance of such conditions at the highest possible standard.

Small-Holdings.—The Institute's two Small-Holdings Officers were as in the previous year stationed at Gampola and Baddegama and intensive work was carried out on the holdings in these areas. A very successful competition was held in the Uda-Nuwara Palata, the object being to encourage small-holders to adopt better methods of cultivation and maintain their holdings in good condition. Excellent work was carried out by many of the holders. It is regrettable, however, that this does not in present circumstances receive a more material reward, the holdings remaining on the same basis of assessment whether they are properly worked or completely neglected.

Acknowledgments.—As in previous years our thanks are due to the Nayabedde Tea Co., Ltd., Messrs. George Steuart & Co., the Amalgamated Tea Estates Co., Ltd.; the Anglo-American Direct Tea Trading Co., Messrs. James Finlay & Co., Ltd., and the Superintendents of Gonakelle, Galatura and Wikiliya estates for facilities afforded to the Institute.

Agency firms and brokers both in London and Colombo have done much to assist us by co-operating in experimental work and we must particularly acknowledge our indebtedness to Messrs. Wilson, Smithett & Co., and Messrs. George White & Co. in London and to the following Colombo firms: Messrs. Forbes & Walker, Messrs. Harrisons & Crosfield, Ltd., Messrs. Whittall & Co., Messrs. the Colombo Commercial Co., Ltd., Messrs. Carson & Co., Ltd., Messrs. Brooke Bond (Ceylon) Ltd., Messrs. Heath & Co., Messrs. Lipton Ltd., Messrs. Somerville & Co., Messrs. George Steuart & Co., Messrs. Mackwoods Ltd., Messrs. Lee, Hedges & Co., Ltd., Messrs. Leechman & Co. and Messrs. E. John & Co.

Mr. R. H. Horne, and since his departure on leave, Mr. L. C. A. Leefe, has kindly acted as convener of the tasting team in Colombo, while Mr. E. Loudon-Shand has acted in a similar capacity in London.

Engineering firms have given us much assistance and we are particularly indebted to Mr. F. J. Whitehead whose invaluable advice has as

always been freely at our disposal. Mr. R. H. Salmon and Mr. W. F. A. Ridler gave valuable help in the drawing up the plans for the experimental drier.

Acknowledgment must be made to the numerous planters who have extended hospitality to the Staff and who have afforded facilities on their estates for the work of the Institute.

Finally, reference must be made to Mr. J. W. Ferguson. Mr. Ferguson has acted as Visiting Agent since St. Coombs Estate was acquired by the Institute and the severance of his connection with the Institute on his retirement will be greatly regretted. His services extend far beyond those rendered in his official capacity and the grateful thanks of the Institute are due to him for the ungrudging manner in which he has given the advantage of his wide experience.

The Reports of the Scientific Staff are appended.

ROLAND V. NORRIS,

Director.

REPORT

OF

THE MYCOLOGIST

FOR 1936.

Staff.—There has been no change in the staff of this division during the year.

Advisory.—533 letters were received and 464 despatched. The corresponding figures for 1935 were 345 and 312 respectively. An increase in advisory work is also shown by the number of consignments of plants received for examination which amounted to 195 as compared with 134 for 1935. Of the 195 consignments 152 were tea; the remainder consisted of Acacia, Albizzia, Citrus, Crotalaria, Cupressus, Dadap, Gliricidia, Grevillea and Tephrosia. Of the tea specimens 78 were affected by diseases of the root, 33 of the stem, 14 of the leaf, and 27 were miscellaneous. Of the root diseases 33 were Poria, 20 Ustulina, 18 Brown root disease, and 7 Rosellinia.

Visits to 25 estates were made for investigational and advisory purposes in the Agrapatna, Badulla, Bandarawela, Dickoya, Dimbula, Dolosbage, Galle, Haputale, Hewaheta, Kandapola and Ratnapura districts.

Two addresses were given to the Dickoya and Dimbula District Planters' Associations.

Poria.—Increased interest in the treatment of root diseases, particularly of that caused by *Poria hypolateritia* has been shown generally through the tea districts, and the substitution of root examination for trench construction is gradually becoming adopted as the routine treatment.

Observations on the incidence and treatment of this disease on St. Coombs have been continued. The total number of plots now under observation is 115, as 20 new ones were located during the year. These areas are new only in the sense that no diseased bush has been removed from them since 1933 when this division took over the work.

From these 20 new plots, 40 dead or obviously dying bushes were removed together with 106 which appeared perfectly healthy as viewed above ground, yet which were more or less severely infected as disclosed by root examination. The ratio of dying to apparently healthy bushes was therefore 1 :2.6.

Emphasis must be laid on the importance of the removal of all infected bushes, no matter whether they appear healthy above ground or not. It will be evident that the removal of 40 moribund bushes will do little towards the eradication of the disease if 106 others with the disease on their roots are left in the ground.

The data given in Table I will further illustrate this point. From the six plots enumerated in that table 57 bushes were removed in 1933. As no root examinations were made that year the bushes were all obviously sickly. All were found to be very severely infected and if not already dead could not be expected to live more than a few months. In 1934, 89 bushes were removed from the same plots. These, however, were not all obviously sickly. Examination of all bushes on the perimeter of the patches was made by lightly scraping the soil away from the collar and those bushes on which the fungus could be seen in that region were uprooted. They all proved to be heavily infected.

TABLE I.

	DISEASED BUSHES			REMOVED 1936	
Plot No.	1933	1934	1935	Dying	Infected
3/11	8	10	1	5	7
3/24	11	26	5	7	26
3/25	6	17	0	4	4
3/34	10	10	1	7	15
8/10	0	12	4	2	13
8/11	12	14	3	2	9
Total	57	89	14	27	74
					101

In 1935 it became obvious that the collar examinations carried out the previous year had not resulted in the elimination of the disease as 14 diseased bushes had to be removed. No root examinations were made, and the uprooted bushes were all obviously sickly and proved to be heavily infected.

During the early months of 1936 dead and dying bushes only were removed, but towards the end of the year it was decided to clean up these plots and to ascertain the existing disease position more exactly. Root examination was made of all bushes on the perimeter and those bushes on

which the fungus was seen were uprooted. The uprooted bushes have been recorded in the table in two categories (1) *Dying,* in which are included all bushes which were dead or obviously dying and (2) *Infected* which is comprised of bushes which above ground appeared normally healthy although the roots are infected. Of the 101 bushes uprooted, 74 appeared normally healthy, and the ratio of dying to infected is 1 :2.7 which closely approximates that found in the 20 new patches mentioned earlier.

It appears, therefore, that the removal of diseased bushes from 1933 onwards had done little towards eradicating the disease. The increased removals in 1934 resulted in a decrease of deaths in 1935, but towards the end of 1936 the disease position had reached normality.

The examination of bushes in the early stage of infection has shown that although in many cases an upper lateral is the first to become infected several instances have occurred in which infection occurred on lower laterals or near the base of the taproots. Examination of roots *in situ* is, therefore, somewhat unreliable unless practically the whole of the root system is explored. For this reason estates are recommended to continue the removal of bushes from the perimeter of any Poria patch until a ring of healthy bushes has been uprooted. This ensures the removal of every diseased bush and makes the eradication of the disease possible.

It is imperative that all diseased roots and woody matter must be removed from the areas infected by Poria. If this is done, is there any possibility of infection occurring later from any fungus which may have been left in the soil ? In February, 1935, the soil shaken off diseased bushes was placed in a 12-inch pot and sown with *Tephrosia vogelii* seed. After 22 months all five plants were alive and healthy and an examination of their roots failed to reveal the presence of the fungus. In some of the field plots which have had all Poria infected bushes removed and then been sown with *Tephrosia vogelii* a few of the plants have died of the Poria root disease, but in every case so far, small tea roots which have been overlooked in the cleaning process have been found in close proximity to the diseased plants. The evidence so far obtained, therefore, indicates that soil which is freed from diseased roots is non-infectious.

Brown Root Disease.—There has been a marked increase in the number of bushes diagnosed as having been killed by Brown Root disease during the year. This is probably more an indication of the increased interest in root disease generally than of an increased incidence of the disease.

This disease is always associated with the presence of stumps of felled shade or jungle trees and infection can almost invariably be traced from a root of the stump to a tea root in direct contact with it. Where shade trees, particularly Grevillea, are felled in large numbers the risk of this disease intervening may be great and the consequences somewhat serious.

An interesting case was recorded this year on an estate from which about 6,000 Grevillea trees had been felled. Brown Root disease began to make its appearance in the tea about 2 years after felling the Grevilleas, and over 3,000 tea bushes have had to be removed. The Grevillea trees at the time of felling were perfectly healthy and those trees which were left standing still remain healthy. Yet of the 6,000 stumps resulting from felling about 2,000, or 30 per cent, have given rise to this disease.

These figures are of particular interest in that they demonstrate the speed with which this fungus, *Fomes noxius,* can operate. During the two years which elapse between felling and the visible occurrence of the disease as shown by dying tea bushes the following stages must occur :—

1. The stump becomes infected by the fungus. This results from the deposition of spores from the air on the cut surface of the stump.

2. The fungus permeates the stump and its roots. The fungus grows most rapidly in the outer zones of the stump, *i.e.,* in the sap wood.

3. The fungus passes from the stump's roots to a tea root and so causes infection of the bush and results in its death.

Two years appear to be a surprisingly short period for the completion of these stages, particularly if the fact is borne in mind that *Poria hypolateritia* may take more than two years to kill a tea bush after the latter has become infected. Evidently if any advantage is to be obtained by the extraction of stumps it should be done immediately after felling.

That so many stumps should become infected almost simultaneously is also surprising. It implies a very heavy spore dispersal. If 2,000 spores found suitable lodgment on stumps the number which failed to find similar resting places on which to develop must be immense. The fructifications of this fungus are not common, at least on tea estates, and the source of this immense spore production is unknown. It seems probable that *Fomes noxius* produces a type of spore which as yet has not been recognised and described.

Rosellinia Arcuata.—An extensive spread of this root disease has been observed on an estate which had a thick layer of fallen leaf on the surface of the soil. The fungus had grown along the surface of the soil and through the layer of dead leaf and had attacked the tea bushes at the collar. It is not unusual to find Rosellinia among the fallen leaves below bushes on the edge of diseased patches, but this case was remarkable because of the large area invaded by the fungus, and the number of tea bushes affected.

Infected bushes could be recognised by scraping away the litter from around the stem when the black fungus could be seen growing upwards along the stems and downwards on to the roots.

That Rosellinia can grow freely through leaf mould must be taken into consideration when control measures are undertaken. Not only the treated area but also the ground on the perimeter of patch should be kept free of fallen leaves.

Infection at the collar results in the bush becoming ringed or girdled but some considerable time elapses before the bush dies if the attack proceeds no further. Where prolonged dry weather, such as is experienced in Uva, intervenes soon after the collar is attacked, the mycelium will develop no further and in some cases may die. Callus develops later at the upper edge of the ringed area but such bushes never recover. The amount of callus growth formed affords some measure of the time which has elapsed between girdling and death. This type of diseased bush has frequently been found in the dry zone.

It is unfortunate that Rosellinia should be prevalent in those areas where a litter of fallen leaves is of great value in counteracting drought conditions and preventing "dry wash". There is, however, little danger of Rosellinia spreading through the mulch during dry weather. During the wet season, however, the mulch should be kept away from the main stems of tea bushes on those estates on which Rosellinia is known to occur.

Phloem Necrosis.—A new disease of tea has been observed during the year in one planting district. The field symptoms are not very clearly defined. To estate superintendents the affected bushes are dwarfed or stunted and non-yielding; the leaves are small, hard and somewhat distorted. Poorness of jât and non-productivity are the main characteristics.

Poorness of jât and non-productivity are not of themselves necessarily symptoms of disease. The diseased bushes usually show clear indications of at one time having been of higher jât, and sometimes a few large, high jât leaves can be found near the base of the branches. This suggests a degeneration in type of the bush, in which case the degeneration has probably been very slow, almost imperceptible. In advanced stages the bushes carry but few branches, which are thin and bear small, distorted leaves, although the frames show that at one time good, thick, normal branches have been produced. In the early stages the bush carries a fair cover of leaf which, however, is small and hard, the leaves particularly at the ends of the branches being closely crowded together.

The leaves in cross section are somewhat V-shaped, the midrib forming the base of the V. That condition is frequently seen in some types of healthy bushes and of itself is not diagnostic. In addition to being V-shaped the leaves are arched backwards. In some cases the leaves are markedly curled and the bushes can be recognised at a distance by the curly leaves. Bushes which have markedly curled leaves usually have longer internodes, *i.e.*, the leaves are not so densely crowded as is the case where the leaf symptom is more an arch than a curl.

Affected bushes frequently make a poor recovery from pruning. Growth is delayed and when it occurs the new branches display the symptoms described above.

As a rule there is no marked yellowing of the leaves although a few instances have been seen where the leaves are yellowish or mottled green and yellow. Such cases have usually had a scorch on the leaf edges and the leaves have been markedly curled. Normally the leaves are green and apparently healthy, *i.e.*, with no lesions or dead tissue on the margin.

The most pronounced symptom, however, is to be found in the woody roots. These appear healthy and normally have a thick, red cortex. When, however, the cortex is sliced with a knife so that the cut passes very close to the cambium or just touches the wood, yellow brown or dark brown spots of varying size can be seen. In the early stage of the disease these dead areas are difficult to determine with the naked eye although a yellowish tinge on the cambium is indicative. In later stages the dead areas are larger and can easily be seen.

Owing to the occurrence of these dead areas in the inner bark the name *Phloem necrosis* has been tentatively applied to this disease although "Curly leaf" is more likely to be a popular name should that character prove to be consistent.

The cause and, consequently, the treatment of this disease are at present unknown.

Polyclady.—Another type of non-productive bush has also been observed. This is characterised by a prolific production of small whippy branches from below ground level. The bush appears as a very compact tuft; the leaves are small and hard and the branches wiry and closer together than the stubble of a wheat field. There is very little indication of a main frame. The root system is abnormal and the roots tend to turn upwards and give rise to numerous branches. Although many form upright wiry stems a large number of others never reach the light of day. They occur as white, spirally-curled stems below ground.

No characteristic lesions have been found in stems, leaves or roots and there is no indication that the bushes have ever been of higher jât. No explanation can be given for this excessive production of branches or root suckering. The extent to which this condition occurs is at present unknown although a good number were found on one estate.

A polycladous bush may also be affected by *Phloem necrosis* in which case it develops the symptoms of that disease and exhibits the necrotic areas in the root cortex.

Crotalaria Leaf Spot.—The identity of the species of *Ceratophorum* which causes the leaf spot and defoliation of Crotalarias described in the

Annual Report for 1934 has now been established as *C. setosum* O. Kirch. which is reported to be the cause of leaf disease of Lupins and Cytisus in Europe.

The Central Bureau fur Schimmelcultuurs, Baarn, to whom our thanks are tendered, kindly supplied a pure culture of the European fungus for comparison with the Ceylon strain. Certain minor cultural differences were observed, but inoculation experiments demonstrated that the Ceylon strain will attack *Lupinus polyphyllus* as readily as the European strain does. The two strains give similar results when inoculated on leaves of *Crotalaria usaramoensis*.

Cercosporella Theae on Tephrosia Radicans.—During the South-West Monsoon a plot of *Tephrosia radicans* was severely attacked by *Cercosporella theae*. The disease resulted in the death and decay of the leaves and a dieback of the creeping stems. The dead leaves bore large numbers of conidia of the normal Cercosporella type and these were found on experiment to attack tea flush as readily as do the Tea and Acacia strains.

On the Tephrosia stems were found a few perithecia of a species of Calonectria similar to that reported earlier in pure cultures of *Cercosporella theae* isolated from tea leaf. Similar perithecia have been obtained in pure cultures of the Cercosporella isolated from *T. radicans*.

Small-Holdings.—A tour of the tea small-holdings in the Kandu Palata, Meda Palata, and Ganga Palata Korales of the Central Province was made during the week November 2nd to 7th inclusive in order to allot prizes in three competitions organised by this Institute. The 90 best holdings were examined in detail and a report on their condition was published in *The Tea Quarterly* Vol. IX, pages 193 to 198.

The Tea Export Controller in his Annual Report for the third year of restriction, April 1st, 1935 to March 31st, 1936, states: "Owing to the transferability of coupons a number of estates which were originally assessed on their crop figures of 1931-32, or on the district average, or by inspection and special assessment have, by neglect, deteriorated to such extent that at present they may not be able to produce their assessed standard crops." These remarks, as the Controller points out, apply with greater force to small-holdings.

Small-holders, almost without exception, sell their coupons separately and the sale of green leaf alone is unremunerative at present. Consequently the entire income from tea small-holdings is derived solely from the sale of coupons and there is no incentive to maintain the holdings in good agricultural condition. The income remains constant whether the holding is neglected or not. Despite this, in certain districts, many have been vastly improved by cultural operations and soil erosion preventive measures.

The deterioration of village agricultural land is a matter of grave importance as ultimately it must materially affect the villagers' welfare. A scheme by which assessment of holdings is made more dependent upon their agricultural condition appears essential. It would supply a stimulus to agricultural endeavour as neglect would be followed by a decrease and improvements rewarded by an increase in assessment. The distribution of coupons as between estates and small-holdings should of course not be affected.

Although it is well known that much of the soil erosion which occurs on village lands is due to the lack of efficient drainage the difficulties experienced in draining individual holdings are not generally realised. The owner of one or two acres when contemplating the drainage of his land is faced with the problem of what to do with his run-off. He may be surrounded by other undrained agricultural lands, or his land may slope down to paddy land or an undrained Gansabawa road. In either case he finds himself without an outlet for his drainage water. If the problem of soil erosion on village lands is to be tackled seriously, communal drainage schemes embracing large areas will become necessary.

C. H. GADD,
Mycologist.

REPORT

OF

THE ENTOMOLOGIST

FOR 1936.

Staff.—There were no changes in the Staff in 1936.

Advisory Work.—644 letters of enquiry were received and 731 despatched, while 246 specimens were examined and reported upon; 99 visits were made to estates.

Passara Sub-Station.—This station was completed at the end of 1935. During the year an acre of land was fenced off round the station and partly cleared. The bank round the laboratory was revetted with stone work, and planted with grass, and numerous shrubs and trees put out. A number of tea stumps were planted at varying intervals for future experimental use, and plots laid out for green manures for the Agricultural Chemist.

Work was begun on Shot-hole borer and a series of experiments supervised for the Agricultural Chemist. Owing to the time necessitated by these, it was necessary to curtail some of the work on Nettle Grub.

Nettle Grubs.—These pests were considerably less in evidence than for several years past. Only 17 estates out of a total of 111 in Uva were affected to any extent, of which three big groups had it throughout the year, the remaining 14 having it for about 2 months only. A noticeable feature was the absence of the pest from some estates on which not long ago it was looked upon as chronic.

All affected estates adopted some measure of control, as required by the Pest Ordinance, which included the collection of grubs and cocoons, spraying with soap and water, and by advancing pruning so that the grubs were caught in the young stage and starved to death. This is the most satisfactory method of control, where it can be done, as long as it is carried out at the correct time, which is immediately after oviposition ceases. Apart from pruning spraying is satisfactory in the later stages, and was carried out more extensively than before. The machine designed especially for this work by the Institute is now to be stocked in Ceylon by Messrs. Walker & Greig, Ltd.

The position with regard to Nettle Grub in Uva is summarised in Tables I, II and III.

TABLE I.

NETTLE GRUB RETURNS 1936.

		Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
BADULLA DISTRICT 46 estates supplied with post cards. Total acreage under tea = 31,686.	No. of estates which sent in returns	22	23	24	22	19	23	22	23	23	21	20	20
	,, ,, ,, declared free of pest	20	22	23	20	17	20	17	20	22	20	18	18
	,, ,, ,, reported outbreaks	2	1	1	2	2	3	5	3	1	1	2	2
	Total acreage affected	142	103	21	178	159	357	362	194	212	52	537	511
PASSARA DISTRICT 9 estates supplied with post cards. Total acreage under tea = 9,447.	No. of estates which sent in returns	7	9	9	9	8	8	9	9	9	9	9	9
	,, ,, ,, declared free of pest	5	7	5	5	5	4	5	6	7	7	7	8
	,, ,, ,, reported outbreaks	2	2	4	4	3	4	4	3	2	2	2	1
	Total acreage affected	37	293	251	305	272	400	304	244	158	26	102	125
MADULSIMA DISTRICT (Including Lunugala) 14 estates supplied with post cards. Total acreage under tea = 10,654.	No. of estates which sent in returns	9	10	9	9	9	9	9	9	9	9	9	9
	,, ,, ,, declared free of pest	9	10	8	6	7	9	8	9	9	9	9	9
	,, ,, ,, reported outbreaks	—	—	1	3	2	—	1	—	—		—	
	Total acreage affected	—	—	55	90	118	—	20	—	—	—	—	
HAPUTALE DISTRICT (Including West Haputale) 42 estates supplied with post cards. Total acreage under tea = 22,065.	No. of estates which sent in returns	17	19	16	15	14	14	14	15	17	17	15	15
	,, ,, ,, declared free of pest	17	19	16	14	13	14	14	15	16	16	14	14
	,, ,, ,, reported outbreaks				1	1	—	—	—	1	1	1	1
	Total acreage affected	—	—	—	15	15	—	—	—	1	15	15	15
UVA (Above districts only) 111 estates supplied with post cards. Total acreage under tea = 73,852.	Total No. of estates which sent in returns	55	61	58	55	50	54	54	56	58	56	53	53
	,, ,, ,, ,, declared free of pest	51	58	52	45	42	47	44	50	54	32	48	49
	,, ,, ,, ,, reported outbreaks	4	3	6	10	8	7	10	6	4	4	5	4
	Total acreage affected	179	396	327	588	564	757	686	438	371	93	654	651
	Percentage (acreage) infection per month	0·24	0·54	0·44	0·80	0·76	1·03	0·93	0·50	0·59	0·13	0·89	0·88

TABLE II.

SUMMARY OF NETTLE GRUB OUTBREAKS IN UVA DURING 1936.

1936	Badulla District*			Passara District			Other Districts**			Whole of Uva			
	Estates affected	Out-breaks	Acreage attacked	Estates affected	Out-breaks	Acreage attacked	Estates affected	Out-breaks	Acreage attacked	Estates affected	Out-breaks	Acreage affected	% Acreage affected
January	2	3	142	2	3	37	—	—	—	4	6	179	0.24
February	1	3	103	2	3	293	—	—	—	3	6	396	0·54
March	1	2	21	4	6	251	1	1	55	6	9	327	0·44
April	2	3	178	4	7	305	4	4	105	10	14	588	0·80
May	2	5	159	3	5	272	3	3	133	8	13	564	0·76
June	3	6	357	4	8	400	—	—	—	7	14	757	1·03
July	5	7	362	4	7	304	1	1	20	10	15	686	0·93
August	3	4	194	3	5	244	—	—	—	6	9	438	0·59
September	1	3	212	2	3	158	1	1	1	4	7	371	0·50
October	1	2	52	2	3	26	1	1	15	4	6	93	0·13
November	2	5	537	2	2	102	1	1	15	5	8	654	0·89
December	2	5	511	1	1	125	1	1	15	4	7	651	0·88

* Includes Namunukula.

** Includes Haputale, Madulsima and Lunugala Districts.

TABLE III.—NETTLE GRUBS IN UVA, 1931—1936.

Planting District		1931	1932	1933	1934	1935	1936
Badulla	Average No.-of outbreaks per month	7.5	5.3	6.6	5.0	3.5	4.0
	Average acreage affected per month	373	439	333	217	143	236
	Acreage under tea	32600	33000	33200	33300	33300	33300
Passara	Average No. of outbreaks per month	7	4	4.5	7.5	9	4.4
	Average acreage affected per month	727	390	250	251	229	210
	Acreage under tea	9800	9800	9850	9850	9850	9850
Haputale and Haputale West	Average No. of outbreaks per month	2	1	0.5	0.2	0.25	0.5
	Average acreage affected per month	180	46	22	0.2	75	6
	Acreage under tea	25600	25600	25700	25800	25800	25800
Madulsima and Lunugala	Average No. of outbreaks per month	2	0.2	1	0.5	0.5	0.58
	Average acreage affected per month	101	1	43	5	5	24
	Acreage under tea	10000	10000	10000	10000	10000	10000
Uva	Average No. of outbreaks per month	18.5	10.7	12.5	13	10	9.5
	Average acreage affected per month	1381	876	648	773	384	475
	Acreage under tea	78000	78400	78750	78950	78950	78950
	Percentage infection per month	1.77	1.12	0.81	0.98	0.49	0.60

Shot-Hole Borer.—Preliminary work on this pest was begun in 1936, intended chiefly to open up profitable lines of research.

Endeavours were made to find out the life-history, if possible, but as it takes place in an entirely concealed position, it is only possible to arrive at results by inference. A large number of branches was marked, and the position of holes noted, so that future holes could be checked off as made and later, groups of branches were opened up at stated times. 700 branches were examined and the contents of 457 galleries were tabulated. In this way it was found that no eggs were laid before 10 days had elapsed, the earliest larvae were found after 14 days, pupae after 27 days and adults after 34 days, thus giving rough figures as follows:—

Incubation period of egg	...	4 days.
Larval period	... ...	13 days.
Pupal period	... ...	7 days.

Cycle about 24 days.

Eggs appear to be laid for a considerable time by one female, so that there are no well-defined generations.

The thickness of branches most attractive to the beetle for excavation proved to be 10 to 12 mm. but those galleries showing the most numerous population were from 14.5 to 16.5 mm. thick.

As there were some manurial experimental plots at hand which were due for pruning, advantage was taken of the fact to invstigate the relationship between Shot-hole borer and tea treated in different ways. The results obtained confirmed those previously demonstrated by Messrs. Jepson and Gadd, described in Bulletin 78 of the Department of Agriculture, the chief of which is that nitrogenous manures markedly accelerate the healing of the galleries. Since some of the damage to bushes is due to the mining of the branches and the snapping off at weak places, it is important to know that such damage can be minimised by adequate manuring. It is to be noted also that this damage invariably appears more pronounced when for some reason regular manuring is stopped, or when there is a prolonged period of drought, although the actual borer population may be the same.

Tortrix.—Tortrix was less in evidence than usual at the beginning of the year, but showed signs of developing in November, into a fair degree of attack in January, 1937. In September, further consignments of parasites were received from the Experimental Station, Java, for observation and use, and most were liberated in the field where Tortrix could be found; some of these were put out in a small area at Diyagama. In May some Java parasites were found in the field, being the fourth generation of those received from Java in November, 1935, and in December some second generation parasites were found derived from the September, 1936 liberation.

A definite plan for the collection of eggmasses at certain times of the year was further investigated at St. Coombs, and further information was obtained from Maskeliya during the year. As data on this subject has now been accumulated for five years, and found to be consistent from year to year, the results were assembled and used for a paper to be read at the biennial conference, subsequently to be published in *The Tea Quarterly*. In brief, it is demonstrated that there are five definite and quite distinct generations of Tortrix every year, the maximum being in January-February and the minimum in June-July. The oviposition periods being sharply definied, collection should be restricted to these periods only, leaving out the June period altogether, and usually also the April one, and confining collection to tea over nine months old from pruning. Both pluckers and podians should be put on to collect at the given times.

Tea Mites.—*Red Spider* was fairly widespread in the Pussellawa district in September, being the first indication of it here for some years past.

Yellow Mite was again prevalent in various places on the flush. About 50 lbs. of sulphur per acre should be applied after pruning to those fields liable to infestation.

Helopeltis.—This bug was reported from Deniyaya as doing some damage in the early part of the year. It was also present to a small extent in Rakwana. Experimental work has been started in Deniyaya to devise some method of coping with it, and it seems as if a sudden appearance of the pest may be dealt with by spraying with soap and water at the rate of one pound to 10 gallons of water as soon as an attack is noticed. It seems to be generally agreed that China jâts suffer most from Helopeltis, and the higher the jât the less it is attacked. The obvious remedy is, therefore, the replacement of low jât bushes by the highest types obtainable, otherwise suitable for the district.

About 30 years ago, the active range of Helopeltis was considerably greater than it is now, but it is difficult to assign any definite reason for its decrease.

Termites.—These pests were formerly under investigation by the Department of Agriculture, but now those affecting tea have been taken over by the Institute.

There appears to be some doubt about the effectiveness of the Paris Green treatment, initiated by Mr. Jepson, in Ceylon. This is largely due to the confusion existing between those termites which devour sound wood, and those which attack only diseased wood of which there are many species. It may be said that the work of the scavenger termites is readily apparent, and if the termites are present, they are easily discovered. But the pest termite, such as *Neotermes militaris* works entirely from within the plant, and they are very difficult to find without cutting the bush in two. It is proposed to investigate at an early date an area where these termites are said to be bad, and make an inventory of the state of some hundreds of bushes, from which it is hoped much valuable data may be obtained.

To return to the Paris Green treatment; it has been shown to be effective in killing out 100 per cent of the colony, and therefore is still recommended. In carrying out the treatment, if an apparently new bush is suspected of attack at pruning time it should be injected, and also all bushes adjacent to it, *so long as a cavity is revealed when drilling the hole.* The bulb holding the poison should be filled less than half full, and all holes should be drilled and injections made in an upward direction where possible, but never below the horizontal. If this method is followed, there should be little likelihood of the poison being left round the entrance of the borehole. Should this happen, some of the wood is killed above and below, and to some extent each side, forming an oval area of dead wood.

After some time, the spread is arrested, and the bush appears to be little the worse, except that if the bore is immediately under a healthy branch the latter may be killed; such places should, therefore, be avoided. Bushes treated several years ago showing this local damage do not appear to be otherwise affected. A piece of stiff wire should be carried with the bulb to clear the nozzle when it gets clogged.

Note.—The Institute deals with all questions of Termites attacking tea. By arrangement with the Department of Agriculture, it also deals with termite-infested buildings, but *only* on estates where there is no other crop but tea.

C. B. REDMAN KING,
Entomologist.

REPORT

OF

THE AGRICULTURAL CHEMIST

FOR 1936.

Staff.—The Agricultural Chemist proceeded on leave on October 28th. Dr. J. G. Shrikhande joined the department on January 21st, but was absent on sick leave from August to the end of the year.

Advisory.—483 letters were received and 509 despatched.

Visits.—18 visits were made to estates and to the sub-stations.

Lectures.—A lecture on "The use of Green Manures and Waste Materials" was given before the Uva Planters' Association and the Madulkelle District Planters' Association.

Publications.—Bulletin No. 14—"Report on a Visit to Tea Districts of North-East India." Bulletin No. 16—"Selected Notes on the Manuring of Tea."

Advisory correspondence has continued to grow in bulk with the result that the senior officer of the department has had a diminished amount of time for individual research. Without wishing to discourage this expansion in the very least, it may be pointed out that a fair proportion of the enquiries received are very indefinite in nature, and entail additional correspondence before an answer to the queries can be given. Particularly with regard to manurial enquiries, it frequently happens that no summary of present practice and conditions is given. Attention is drawn to the Editorial in the June number of *The Tea Quarterly*, Vol. 9, 1936, Part 2, where details are given of the information required in order satisfactorily to answer enquiries of this type.

The Supply of Organic Matter to the Soil.—This subject continues to be one of the chief subjects of interest and discussion in Ceylon. Force of circumstances has tended to narrow the field of interest amongst the planting community to the question of the respective merits and demerits of composting and green-manuring. Whilst this aspect has naturally received attention, this department is interested in the wider question of organic matter in general.

Composition of Vegetable Materials and Composts.—In the last report, the conditions under which composting was necessary were defined on the basis of the carbon-nitrogen ratio. Attention has been directed to the composition of Ceylon materials. Table I gives the details for representatives of those types of materials most commonly used.

TABLE I.

COMPOSITION OF VARIOUS MATERIALS WITH RESPECT TO CARBON AND NITROGEN.

Material	Carbon per cent	Nitrogen per cent	Ratio C/N
Leaf from tea prunings ...	43.65	2.52	17.3
Dadaps (loppings) ...	45.39	4.06	11.2
Gliricidia (loppings) ...	41.64	3.52	11.8
Grevillea (droppings) ...	49.22	0.85	57.9
Tephrosia vogelii (loppings) ...	45.08	3.92	11.5
Tithonia diversifolia (Sunflower) ...	33.08	3.38	9.8
Maana grass ...	45.29	1.68	26.9
Refuse tea ...	38.62	4.60	8.4

Of these materials only grevillea droppings and maana grass stand out as being far removed from the accepted criterion of suitability for direct use, if by suitability non-liability to cause nitrogen starvation in the soil is understood.

The behaviour of composted materials towards dilute hydrogen peroxide has been used at Indore and elsewhere as a criterion of humification, and in the form of a humification index, *i.e.*, loss of weight after hydrogen peroxide treatment expressed as a percentage of total organic matter, has proved useful in tracing the progress of fermentation particularly in the case of resistant materials. Some doubt exists as to whether this is a useful index in the cases of compost made from materials of low carbon-nitrogen ratio by reason of the fact that it has been shown by other workers that much of the nitrogen in these substances already exists as water-soluble protein.

Examination in these laboratories tends to confirm this doubt, and indirectly confirms the point that green manures contain a good deal of readily available nitrogen. A value comparable with the empirical humification index has been found for several of the raw materials.

These results, given in Table II, have led to the complete investigation of the distribution of nitrogen, carbon, and lignin in the raw materials and the decomposed products. Humus is a term that is frequently used very loosely to cover any complex of decayed vegetable matter. Humus

as a definite chemical compound has received a great deal of attention in recent years with a view to determining its chemical constitution. The results of these investigations point to the fact that humus is a ligno-protein, a compound that releases its nitrogen only with difficulty. This finding is at variance with the claims of ready availability of nutrients made for composted materials. The apparent discrepancy would be resolved if in humus, ordinarily conceived to be the product of the compost heap, there were present in appreciable quantities nitrogenous substances which were not strictly humus at all.

TABLE II

LOSS ON TREATMENT WITH HYDROGEN PEROXIDE AS PERCENTAGE OF ORGANIC MATTER.

Gliricidia	...	46
Grevillea	...	53
Sunflower	...	71
Refuse tea	...	81

In conjunction with the investigation with the fractionation of the components of raw materials, a similar line of approach is being explored using a large number of finished composts. In addition, the nitrification of the various fractions is being closely followed. The results of these experiments are not yet in a stage for report; their aim is described here to indicate the fundamental considerations that are claiming attention, and to indicate that the policy of this department is concerned with something of greater gravity than the superficialities of topical controversy.

Losses of Nitrogen in Compost.—In the last annual report data were given showing that under dry atmospheric conditions compost storage was possible without serious wastage of nutrients. The presence of soluble compounds in compost heaps makes it far otherwise under wet conditions. Moreover, in the actual process of manufacture the possibility of loss is always present. The ordinary estate compost heaps do not allow of a balance sheet of nitrogen to be drawn up, because the quantities and analysis of the materials at both start and finish are not known. From time to time it is possible to collect data of this kind from more carefully controlled manufactures. Several of these have been encountered and the losses range from 8.5 per cent in an estate experimental heap to 46 per cent under ordinary estate conditions. Rainwater compost at Indore shows a loss of 42 per cent so that faulty procedure cannot be blamed. The evidence at hand shows that excessive rain in the later stages of manufacture is responsible, and it may, therefore, be necessary to stop composting during the worst part of the rainy season. No instances of gain in nitrogen during manufacture, such as are reported from Indore, have been encountered.

Effect of Compost on Growth of Tea.—At the beginning of 1932 an experimental area was reserved on St. Coombs for the purpose of studying the effect of organic matter on the cultural properties of soils. Six blocks of $\frac{1}{6}$th acre were supplied with vegetable matter, and six similar and adjacent blocks were left as controls. The land in question carried young tea that had not been brought into bearing.

In order to avoid constant forking in of green manures, it was decided to use composted material which could be collected as occasion allowed. In the course of the four years 1932-1935 inclusive these areas have received an average annual dressing of 15 tons per acre, representing a nett addition of 135 lbs. of nitrogen per acre per annum. The material used for composting was maana grass together with sunflower and bush green manures grown on waste land and in ravines.

The area in question was brought into bearing in April of this year, and at the time of writing, has been tipped three times and is in plucking. The effect of this intensive treatment with bulk manure is strikingly visible in the new growth since pruning, as measured by the yields of the whole tippings. The mean dry weight yields per acre in pounds for the two sets of plots are as follows :—

Control	Composted green stuff
100	217

This result amply demonstrates the advantage of liberal manuring of young tea. How much of the effect is purely nutritional cannot be distinguished, but the high values of nitrogen supplied could hardly fail to make their effect felt. The experiment is being maintained without further additions of compost in order to study residual effects.

This experiment will provide other interesting data. There exists in Ceylon at this time no other experiment from which a clear-cut answer can be obtained on the subject of the influence of compost on quality in tea; where attempts have been made, or are being made, an exact comparison is vitiated by the intrusion of extraneous factors. Arrangements are complete for manufacturing the produce of this experiment contrasting compost with no compost. At the same time a parallel study is being made of the effects of higher doses of artificial nitrogen than has been possible till now. In place of 40 pounds of nitrogen per acre as the standard amount, 80 pounds per acre has been chosen.

Effect of Organic Matter on Soil Properties.—For some time past the department has been anxious to investigate the effect of physical cultivation on tea. This subject will be dealt with in a succeeding paragraph, but is mentioned here because in planning this work methods of measuring the condition of the soil *in situ* have had to be considered, and in our cases some success has been attained with an instrument for measuring the

compactness of the soil. The principle of the instrument used is not new; it is in effect a pile driver; a hollow cylindrical tube with a spear point acts as the probe and is driven into the ground by the impacts of a rod falling a given distance in that tube, the whole instrument being supported with as little friction as possible by a tripod. The instrument is so designed that the work done against the soil resistance can be expressed in the appropriate mechanical units, but as a first approximation the curves (Fig. I) obtained by plotting number of impacts per unit penetration against depth of penetration, give an adequate picture of the character of the soil mass.

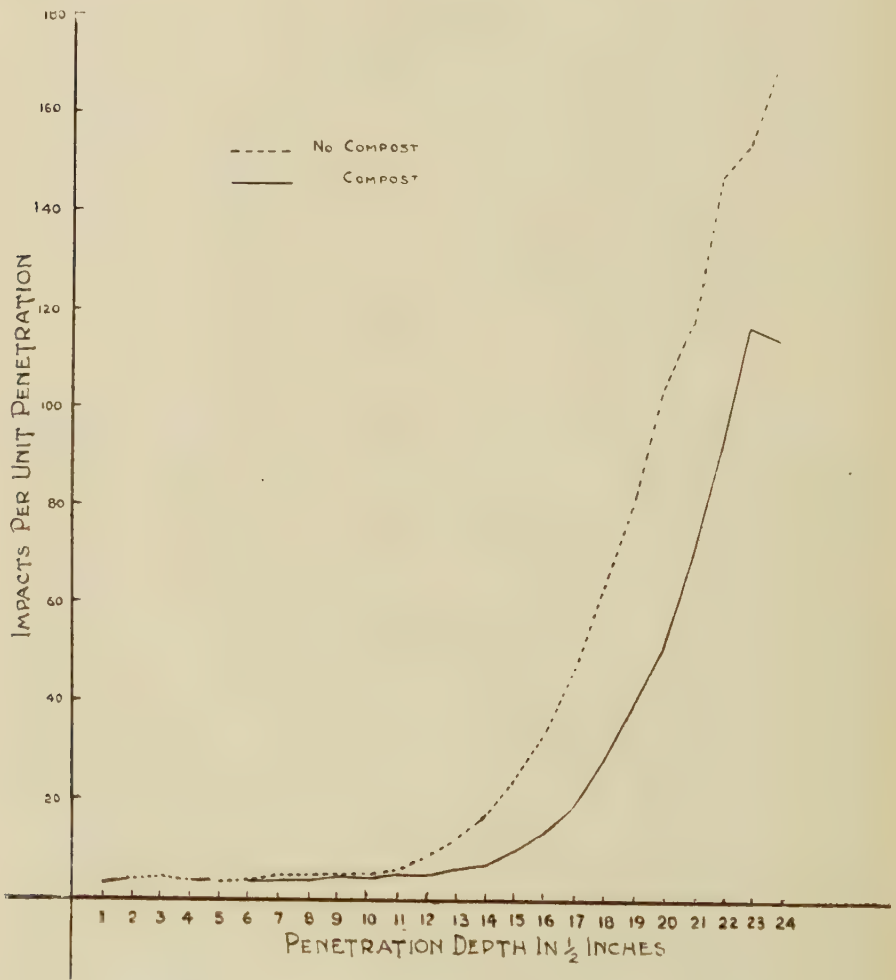


Figure I.

Amongst the preliminary work carried out with this instrument has been a comparison of the compost plots referred to above against their controls. The mean results of twenty-four determinations on comparable

areas of the two sets of plots are shown in the diagram (Fig. I). The plots were cultivated four months before the survey was made, and have received the whole of the rainfall of the South-West Monsoon.

The unit of penetration taken is half-an-inch. For the first eleven units ($5\frac{1}{2}$ inches) the probe has entered uniformly as shown by the parallelism of the penetration-impact curve with respect to the penetration ordinate. Moreover, the two sets of readings are to all intents and purposes identical. At the six-inch level divergence begins, for, thereafter, till about the twentieth unit (10 inches) the impacts required for unit penetration in the plots treated liberally with organic matter is markedly less than for the control. At the ten-inch depth, the force necessary to penetrate unit distance in the former soil is only half that required in the latter. Thereafter the curves, though displaced, run roughly parallel, *i.e.*, the succeeding layers of both soils are similar to one another.

The identity of the curves over the first portion can be accounted for by the thorough disturbance of the soil in both cases by the fork. The major difference between the soils lies in the lower regions of forking. It will be of interest to see whether this difference persists. In passing, it may be noted that the curves show that the effective forking depth is only about ten inches, a good deal less than the length of the fork. The same characteristics has been found on other soils on other estates where this implement has been used.

Other methods of detecting differences have been tried, such as the ease of fracture of solid blocks of soil removed for sieving, and also the moisture-retaining capacity of the soil, but no differences were detected. A repetition under dried soil conditions will be made, and the progress of the normal compacting of the soil followed from time to time.

The Return of Vegetable Matter to the Soil.—The normal practices of shade tree cultivation and pruning of the tea bush ensure that periodically a considerable amount of potential organic matter is returned to the soil. The value of this cyclic phenomenon has been explained frequently and at length in the course of advisory activities, but the contribution that the pruning operation makes to nutrient and humus conservation is frequently rather airily dismissed.

Occasion has been taken to obtain figures for the quantity of tea foliage in different districts with different pruning cycles (Table III). The method employed at all centres except St. Coombs has been to strip, immediately before pruning, all leaves from a large number of units of five consecutive bushes, these units being randomly distributed in the rows sampled. From every row sampled, samples were taken to obtain mean dry weights, and all yields have been reduced to dry matter on this basis.

At St. Coombs bushes were actually pruned and the leaf stripped after drying in the factory loft with hot air.

These figures do not account for the leaf-fall from the growing bushes and from the stand of grevilleas or other shade trees commonly used. This has also been estimated at one centre, Passara, where from twelve experimental plots each of 1/10th acre, the average dry weight of leaf-fall from tea and a good stand of grevillea, gliricidia and albizzia, was found to be 0.80 ton per acre. It thus appears that, in so far as these estates are representative, the total quantity of leaf droppings from pruning and other sources is unlikely to exceed 2½ tons dry matter per acre, unless a considerable proportion of woody material is forked in also.

TABLE III.

FOLIAGE LEAF AT THE TIME OF PRUNING: DRY WEIGHT PER ACRE.

Place	Foliage yield Tons	Acreage sampled	Number of bushes	Months Pruning Cycle	Cycle yield per acre Tea lb.
St. Coombs	0.80	½	1350	36	2100
Dimbula	1.10	5	500	27	1048
Passara	0.86	7	750	27	1327
Ratnapura	1.41	2	500	24*	
Kandapola	1.38	¼	500	62	3195
Peradeniya	0.83	½	500		

* Field rested for 80 days prior to pruning.

Cultivation and Weeding Experiment.—The institution of an experiment to investigate the effect of cultivation and weeds upon the growth and yield of tea has been delayed by the lack of land at St. Coombs suitable for experimental work. Recently, however, another young field has been brought into bearing and a site for such work obtained. The tour of North-East India brought forcibly to notice the difference of procedure and conditions, and has enabled an experiment to be designed which takes advantage of what was seen there, as well as what is the common custom in Java. The Indian experiments as explained in the Report that has been issued, show that cultivation in excess of what is required to check weed-growth is harmful; also that weed-growth exercises a definite competitive effect on tea.

The experiment investigates three main factors which can be tabulated by comparing the opposing main treatments:—

(1) Clean weeding *versus* selective weeding.
(Selective weeding entails the removal of grasses only.)

(2) Forking *versus* no forking.

(3) Double dose of manure *versus* single dose.
(A single dose supplies Nitrogen 40 lbs.; Phosphoric acid 30 lbs.; Potash 20 lbs.)

Both manuring and forking will have an effect on the weed covers, so that their effects in conjunction with each other and with the type of weeding, are of interest. The design has, therefore, been made a factorial one, giving every one of the eight possible combinations of treatments. The actual treatments are conveniently shown by the accompanying diagram (Fig. 2) which shows the scheme, but not the actual arrangement of plots. Each sector represents a treatment, and each treatment has a representative from the main factors 1-3 listed above.

Diagram of Treatments for Cultivation and Weeding Experiment

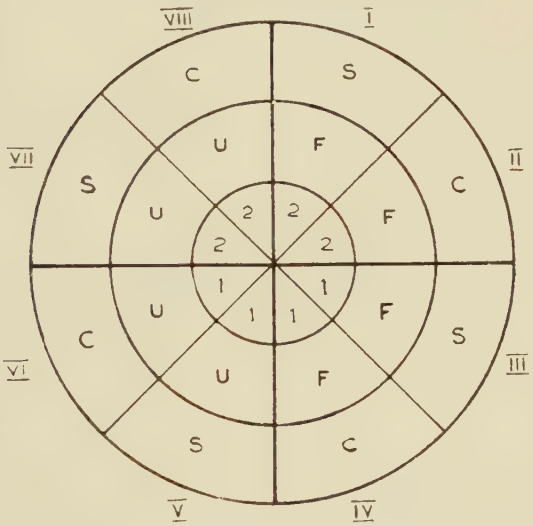


Figure II.

The outer circle represents the weeding scheme, the middle the cultivation scheme, and the inner the manurial scheme. Section I for example represents a plot that is selectively weeded, forked and receives a double dose of manure. It will be noticed that the diagram of treatment is symmetrically distributed about the vertical and horizontal diameters with respect to two of the three factors studied, and that if alternate sectors are also picked out the same applies to them. In this way every plot is made to provide information about each factor, using a minimum of plots,

TABLE IV

YIELDS FROM MANURIAL EXPERIMENT

ST. COOMBS.

Second Cycle; Second year.

NITROGEN

Manurial dressing	0 lb. per acre	20 lb. per acre	40 lb. per acre
Yield per acre lb	766	847	943
Yield % of mean	90	99·5	110·5
Significant difference %*		5·9	

POTASH

Manurial Dressing	0 lb. per acre	20 lb. per acre	40 lb. per acre
Yield per acre lb.	860	851	845
Yield % of mean	101	100	99
Significant difference %		5·9	

PHOSPHATE

Manurial dressing	0 lb. per acre	30 lb. per acre	60 lb. per acre
Yield per acre lb.	817	880	859
Yield % of mean	96	103	101
Significant difference %		5 9	

TYPES OF NITROGEN

Types of nitrogen Equivalent quantities	Sulphate of ammonia	Bloodmeal	Groundnut cake
Yield per acre lb.	923	882	880
Yield % of mean	103	98·5	98
Significant difference %		7·25	

**The significant difference between yields is the amount by which one yield must exceed another, before it can be reliably stated that such yield differences are due to differences of treatment.*

and enhancing the accuracy and representativeness of the various comparisons. There are three sets of this unit of eight plots, and for every comparison made between the three main factors and their various combinations, paired sets of twelve plots will be available. In addition to yield measurements, the changes in density and type of vegetative cover on the selectively weeded plots will be followed.

Manurial Experiments.—(*St. Coombs*).—The nitrogen, potash and phosphate trial has been continued, being now in its fifth year. The results of the year 1935-1936 are shown in Table IV.

The behaviour of nitrogen remains unaltered compared with previous years. There is a substantial increase in yield due to nitrogen, and within the limits of experimental error that increase is proportional to the quantity applied. The yield increment of tea per pound of nitrogen applied, works out at 4.4 which is a little greater than previous years. This is to be expected since there must be a progressive decline in fertility on plots that have received no nitrogen for six years.

The different kinds of nitrogen behave alike to within five per cent, a value that is within the limits of experimental error. This close similarity is very striking when it is realised that it represents the cumulative influence of five years with their admitted variation in seasonal characters.

Potash still continues to show no yield response. On the quality side there is preliminary evidence that it is beneficial; full details of the experiments will be published when the series is complete.

In last year's report the difference in yield caused by phosphatic applications was too small to rely on. This year the cumulative effects are definitely significant. It is of special note that the higher dressing (60 lbs. per acre) shows no superiority over the lower (30 lbs. per acre).

With regard to quantity of nitrogen, type of nitrogen and quantity of phosphoric acid, the valuations of made tea from these plots show that so far no consistent differences in quality of the tea have emerged from the various treatments.

Passara.—The experiment at Passara which deals with manurial deficiencies has completed a pruning cycle.

The yields expressed as a percentage of the mean are as follows:—

Nitrogen at 40 lbs. per acre	...	103
No nitrogen	...	97
Phosphoric acid at 30 lbs. per acre	...	99
No phosphoric acid	...	101
Potash at 40 lbs. per acre	...	100
No potash	...	100

The largest difference, that due to nitrogen, is six per cent and is nevertheless not significant and cannot be relied upon. This failure to get a response to nitrogenous manuring is at variance with the result at St. Coombs, and will be the subject of further consideration. Two suggestions can be made; either the natural condition of the soil is sufficient to supply all that present cropping requires; or the fact that manuring takes place immediately prior to the monsoon may reduce the efficiency of the application.

The lack of phosphate response is not so anomalous, since the evidence collected at St. Coombs shows that there is a time lag before effects become visible; the amount of that lag will depend on the phosphatic status of the soil at the time the experiment was commenced.

The equivalence of the potash and no potash plots is in accord with the results of the St. Coombs trial.

Acknowledgments are due to Mr. Lamb and the Staff of the Biochemical Section for their co-operation in the quality trials.

T. EDEN,
Agricultural Chemist.

REPORT

OF

THE PLANT PHYSIOLOGIST

FOR 1936.

Correspondence.—479 letters were received and 401 despatched.

Visits.—A total of forty-seven visits were made during the year, while lectures were given to three District Planters' Associations.

Staff.—The Plant Physiologist assumed charge of the field experiments of the Agricultural Chemist on the latter's departure on leave on 28th October.

Mr. J. W. Reith resigned his post as Field Assistant on the 30th September and Mr. F. P. Jayawardene was appointed to the vacancy.

Identifications.—An attempt was made in the latter part of the year to collect information upon the experience gained upon estates, of indigenous cover crops which had been identified for them. In the majority of cases useful information was supplied which will be of value to the Institute in its advisory work.

An attempt was made to determine the species of the *Artemisia* found on waste land and cultivated land and spreading by means of underground stems. It normally only grows to about 4 inches in height and has not been known to flower. Attempts to make it flower failed, while growth under comparable conditions indicated that it differed markedly from the normal *Artemisia vulgaris*.

The following report was kindly afforded by the Director, Kew :—

"None of the *Artemisias* from India in any way resemble specimen B. It seems to differ considerably from specimen A (which is typical of the usual form of *A. vulgaris* Linn.) in several points, *e.g.*, habit. texture and shape of leaf, and absence of glands. I do not think that any decision can be reached until inflorescence has been obtained, or the results of the experiment suggested in Dr. Haigh's letter to Dr. Tubbs is known. It is difficult to believe that specimen B is the same species as specimen A."

The Curator of the Herbarium, Buitenzorg, is inclined to consider it a variety of *Artemisia vulgaris,* but the comparisons made of the two plants under similar conditions (the experiment referred to above) in very rich, medium and poor soils suggest two very distinct races, at least. Shortening the length of the day to eight hours over a period of four weeks failed to make long established plants flower.

Should a *dwarf form* be found in flower, I shall be glad of the opportunity of seeing it *in situ.*

The identification of this plant as *Artemisia vulgaris* in the publications of the Institute referring to cover crops must therefore be regarded as doubtful, until further information is available. The botanical description of the plant is as follows :—

Perennial, aerial stems erect, 1-4 in., unbranched, glabrous, internodes short, leaves 1-2 in., petiolate, exstipulate, pinnatisect, segments broadly mucronate, pilose or glabrous above, pubescent and white beneath The stems branch freely beneath the soil, and do not become woody. In contrast to *A. vulgaris* the leaves are less aromatic when crushed and glands are scarce or absent. It has not been known to flower.

TABLE 1

Number of shoots	Area A	Area B
20-39	47	—
40-59	212	—
60-79	302	34
80-99	219	304
100-119	128	330
120-139	52	168
140-159	25	79
160-179	11	41
180-199	3	14
200-219	1	16
220-239	—	6
240-259	—	2
260-279	—	2
280-299	—	1
300-319	—	1
320-339	—	1
340-359	—	1

Propagation.—A start was made upon investigation of possible methods of large-scale propagation of desirable plants towards the end of the year. This is in keeping with the re-orientation of the department's activities, as a result of which experimental work upon the best methods of replanting

and upon improvement of the type of tea planted is to be undertaken. It is hoped to initiate a field experiment in 1937 designed to provide information upon replanting methods.

Further data, amplifying that given in the last annual report, illustrate the need for improvement of plant material. The number of flush shoots yielded over five pluckings in two areas of one thousand bushes varied widely from bush to bush (Table 1). The numbers of bushes falling into different yield classes is shown in the second and third columns.

TABLE 2

		A	B	C
1931,	July.	Planted	Planted	Planted
1933,	April.	Pruned 2 ins. above stump level.	Centered at 3 ins. above ground level.	Centered at 4 ins. above ground level.
	October.		Gourmandisers cut back.	
1934,	May.	Cut 2 ins. above last prune.	Gourmandisers cut back.	Pruned at 10 ins.
	Sept.			Tipped at 6 ins.
	October.		Cut-across at 15 ins.	
1935,	Feb.			1st Plucking.
	March.	Cut-across at 20 ins.		
	June.	Tipped to 1 leaf.		
	August.	1st Plucking.		
	Sept.		Pruned at 12 ins.	
1936,	March.		Tipped at 4 ins.	
	April.		1st Plucking.	
	May.			Cut-across $\frac{1}{2}$-in. above old tipping level and brought into plucking without tipping.
	October.	Pruned 3 ins. above 1934 prune.		

While the majority of the bushes are found to occur in the low-yield classes the situation cannot be regarded with satisfaction, or even equanimity, when the progress that has already been made in other countries is considered.

It is to be hoped that, in those areas that are being replanted, care will be taken to avoid the indiscriminate planting that occurred in the past and that, by careful and vigorous selection of the plants in the nursery beds, a stand of more uniform and more vigorous plants will be achieved.

Pruning of Young Tea.—An experiment at St. Coombs enabled the comparison of the three methods of treating young tea which are described in Table 2. The A series of plots were planted with six-inch stumps, while the B and C series were planted with seedlings from which the leaves and green stems alone were removed.

N.B.—Whenever pruning was performed, spread was encouraged by leaving all lateral twigs situated below the pruning level on the outside of the bush.

The mean diameters of the bushes at ground level and at eighteen inches above before pruning in April, 1933 in cm., are shown in Table 3 :—

TABLE 3

		A	B	C
Ground level	...	1.12	1.47	1.44
Eighteen inches	...	9.6	17.5	13.1

After pruning the percentages of plants bearing laterals and the average numbers of laterals per plant were measured (Table 4).

TABLE 4

		A	B	C
Percentage	...	81.8	25.0	23.5
Mean number	...	1.87	0.38	0.33

It will be seen later that the larger number of laterals found (as to be expected) upon the stumped plants did not permanently influence the spread of the plant. Thus the B and C series of the plants subsequently produced more vigorous lateral growth than the A series.

In addition to the records of yields after the bushes came into plucking, observations upon the spread of the bush at eighteen inches and the growth of the stem at ground level were also made. The figures quoted above give an idea of the form of the bushes in 1933. Their subsequent growth may now be discussed (Table 5).

In 1934 the more rapid growth of the stumped plants near the ground resulted in their thickness at ground level equalling that of the other treatments, and in fact exceeding that of the "C" series. This is probably the result of the growth of the large number of laterals originally present. It may be noted that the "B" series in which gourmandisers were cut back to encourage the production of the lateral branches also showed a greater

increase than did the "C" series on which this was not carried out. The production of laterals near the ground appears to have increased the rate of thickening at the collar, in spite of the check to growth caused by pruning back the gourmandisers.

TABLE 5

Date	Thickness of stem at Ground Level, cm.				Increase since Prior Measurement.			
	A	B	C	Sig. diff.	A	B	C	Sig. diff.
May, 1934. ...	2.23	2.11	1.82	0.28	1.12	0.63	0.37	0.12
May, 1935. ...	3.38	4.02	2.93	0.54	1.14	1.92	1.11	0.40
July, 1936. ...	4.39	4.28	3.99	—	1.01	0.25	1.06	0.60

By May, 1935, the "B" series had grown larger stems, the increase in thickness being relatively large. The harder pruning performed on the other two series resulted in a greater check to growth, which is reflected in the decreased growth in thickness. This effect was again observable the following year, the "A" and "C" series being in plucking, and the "B" series pruned; the new growth of the latter series was much less than that on the two former.

It appears that growth in thickness of the stem at ground level is reduced when the general growth of the bush is checked by pruning, while the final result will be modified by number and position of lateral branches. As data accumulate it may be found possible to utilise this character as a measure of the effect of different types of pruning upon the growth of the bush as a whole.

The diameter of the bush eighteen inches above ground level provides a measure of spread, and therefore of the efficiency of the different systems in this respect. The results obtained to date are shown in Table 6.

TABLE 6

Date	Breadth of Bush at 18 inches in cm.				Increase since Prior Measurement.			
	A	B	C	Sig. diff.	A	B	C	Sig. diff.
May, 1934. ...	36.4	24.9	20.4	6.6	26.8	7.5	7.3	5.5
May, 1935. ...	55.9	57.6	55.0	—	19.5	32.7	34.6	8.6
July, 1936. ...	97.5	77.5	81.5	15.3	41.5	19.9	26.5	—

The larger number of laterals present upon the plants of the "A" series in 1933 is reflected in the greater lateral growth made in the succeeding year, but it will be noted that by 1935 the treatments had resulted in

equality. This may have been due to the low pruning of the "A" series in May, 1934. By July, 1936, the bushes in series "A" were again significantly larger than the remainder.

The yield data so far available are given in Table 7 dating the year from July.

TABLE 7

	Year	A	B	C	Sig. diff.
Annual	1934-35	—	—	89.69	—
yield	1935-36	325.53	72.95	305.10	43.36
Total yield to	1-7-36	325.53	72.95	394.79	44.40
Yield per	1934-35	—	—	5.28	—
plucking	1935-36	8.57	8.10	10.39	—

As far as the results go, it appears that the loss of crop resulting from methods involving delay in the commencement of plucking is not compensated for by a higher yield subsequently. This cannot be attributed to the fact that the bushes were in plucking for varying periods during the year 1935-1936, since the "yield per plucking" shows no significant difference between the different treatments. While final judgment on the results of the experiment must await its completion in 1940, the results so far obtained suggest that it is preferable to bring young plants into bearing as early as possible and that this can be done without prejudicing the spread of the bush.

An examination of the plots in October, 1936, indicated that at this stage there was no difference in the type of frame detectable by the eye. In this connexion, it must be remembered that in each treatment all laterals below the pruning level were left to encourage spread. Had the more common method of removing a large proportion of these been adopted in some of the plots, this result would not have been obtained. For example, measurements made on young tea which had been clean pruned gave an average diameter of 16.2 inches compared to 26.0 inches where a fringe of spreading laterals had been left.

The Length of the Pruning Cycle.—The yield of a bush during the earlier portions of the cycle, when the stimulus resulting from pruning is still marked, appears to be influenced to a lesser extent by variations in the environment than later on. The relative variance of the monthly yields of certain fields at St. Coombs under the same climatic conditions are shown in Table 8.

In one case only is the relative variance of older tea smaller than that of younger. This difference between fields of different ages from pruning

is further illustrated by calculations made on yield data for one year kindly supplied by an estate in the Nuwara Eliya district, which show a similar trend (Table 9.)

TABLE 8

		Age of fields in months	Relative variance
Estate fields 1934	...	7-19	0.062
		13-25	0.157
		15-27	0.191
1935	...	7-19	0.036
		11-23	0.103
Pruning plots 1933	...	8-20	0.073
		12-24	0.086
		16-28	0.116
1934	...	20-32	0.068
		24-36	0.141
		28-40	0.124

Although the differences in the variability of fields of different ages are often not sufficiently marked to be individually significant, taken as a whole they strongly suggest that a real change of the kind suggested does occur. The enhanced variability in old fields may be partly due to shoots being more liable to turn "banji" at some seasons and so providing smaller individual shoot weights, but it seems likely that the main effect is due to the *number* of shoots produced being less liable to change with climatic conditions in fields that have been recently pruned. It is noteworthy that a somewhat similar effect has been noted in rubber where it was found that as trees grew older, their growth became more and more influenced by climatic periodicity. There is some evidence that low jâts may show enhancement of variability earlier after pruning than is the case with higher jâts.

TABLE 9

Months from pruning	...	11-23	24-36	30-42	42-54	47-59
Relative variance	...	0.062	0.071	0.058	0.138	0.156

For a full discussion of the results so far obtained under this heading reference should be made to Bulletin No. 16 and to *Tea Quarterly* Vol. X, p. 21.

Dieback.—Those concerned with tea at medium elevations, while agreeing that dieback after pruning is less on such estates than on those at lower elevations, will point out that it is by no means absent. Provided that a sufficiency of leaf is left on the bush, in the form of lung branches,

or more desirably at higher elevations, a *generous* fringe of unpruned branches on the outside of the bush lying below the future tipping level, cases of dieback due to carbohydrate deficiency are rare. There is, however, a form of dieback found even when the roots are full of starch, and it is very desirable to determine whether the damage caused by it can be alleviated by pruning. This problem has been examined near Badulla, on tea at an elevation of approximately 3,000 feet, clean pruning being compared with lung-pruning. The pruning was done in November, and dieback was pruned out and weighed the following September. Every terminal portion of the frame more than half-an-inch in length not bearing a shoot was removed from the bushes. It may be objected that this process results in the inclusion of a certain amount of quite unavoidable dieback resulting from the pruning cuts not being closely adjacent to a bud. But there is no reason to suppose that the amount of dieback due to this cause would not be equal under both treatments. The inclusion of stems which were not completely dead was also unavoidable, but the eleven months allowed provided ample time for shoots to be produced. The weights removed from 2,400 bushes are shown in Table 10.

TABLE 10

	Lung pruned	Clean pruned
Area A ...	451.62 lb.	454.74 lb.
Area B ...	375.71 ,,	365.32 ,,
Total ...	827.33 lb.	820.06 lb.

The differences are, of course, quite insignificant. There was, however, a difference in the type of dieback which it is at present difficult to explain with any certainty. The mean weights of 100 pieces of dieback wood from area (A) were 0.965 lb. from the lung-pruned plots and 1.161 lb. from the clean-pruned plots. The difference is significant and indicates that the dieback from the clean-pruned plots was made up of a smaller number of larger pieces than that from the lung-pruned plots, indicating its more serious character in the former. While this result may be due to the presence of small pieces removed from the twigs remaining on the lung-pruned branches, it is doubtful whether this accounts for so large a difference as 20.3 per cent between the average size of the pieces of dieback from the two series of plots.

There is reason for suspicion that Shot-hole borer (*Xyleborus* sp.) may be responsible for this dieback, which is certainly quite different in character from that resulting from carbohydrate deficiency. The presence of the galleries produced by the insect in the immediate vicinity of the buds must prejudice the supply of nutrients and therefore the growth of the buds. There is very suggestive evidence that the branches which die back have galleries in the immediate vicinity of the majority of the buds.

Data collected by the Entomological Department provide the basis for this (Table 11.)

TABLE 11

Pruned Branches	Died back	Produced shoots
Percentage of the buds having a gallery in the immediate vicinity ...	81.42	20.97

(Each figure based on 2,500 stems.)

Pruning.—The first cycle (of four years) of the St. Coombs experiment was completed this year. In the first year lung-pruning depressed the yield per plucking compared to clean-pruning and cutting-across at the same level. The two latter treatments did not differ. In subsequent years no significant difference was found between any of the treatments. The yields per plucking, in pounds of dry matter per 250 bushes are shown in Table 12.

TABLE 12

Pruning	Lung	Clean	Cut-across	Sig. diff.
First year ...	1.89	2.00	2.02	0.10
Second year ...	1.87	1.91	1.79	None
Third year ...	1.28	1.34	1.23	None
Fourth year* ...	0.92	1.00	0.91	None

* Plucking tables were levelled by breaking back before the commencement of the fourth year.

It thus appears that at this elevation the type of pruning is only of importance, in relation to yield, in so far as it may affect the number of pluckings and the yield per plucking in the first year, and on the basis

TABLE 13

	Lung	Clean	Cut-across**	Sig. diff.
Low elevation (200 feet)				
First year ...	.147	.147	.131	.003
Second year ...	.124	.125	.121	.001
Mid elevation (1.500 feet)				
First year ...	.144	.144	.136	.004
Second year ...	.119	.119	.118	None
High elevation (4,600 feet)				
First year ...	.110	.111	.109	.002
Second year ...	.091	.091	.090	None
Third year ...	.089	.090	.089	None
Fourth year ...	.087	.087	.087	None

** High cut-across at low and mid elevation. Low cut-across at high elevation.

of the results quoted there is no reason to advocate a change in the normal type of pruning used on up-country estates, save for the important points of improving the spread of the bushes and of providing for steady replacement of frame wood.

Flush Size.—The average weight of one flush, in grammes, in the crops derived from the pruning experiments are shown in Table 13.

The data show that the size of the flush is reduced in the first year by the method (cutting-across) leading to an early formation of the plucking table and an early production of a large number of flushing points, but that in subsequent years this difference is only maintained in the case of the low-country results, where, the formation of an efficient plucking table on clean and lung-pruned bushes continues into the second year. Thus the type of flush obtained early in the cycle of a cut-across field is analogous to what would be obtained rather later in the case of a lung or clean-pruned field. This is also observable in the percentage of flush and banji shoots present. The percentage of flush, as distinct from banji, in the crop from the Galatura pruning plots is shown in Table 14.

TABLE 14

Days from pruning		Lung	Clean	High cut-across
120-141	...	78.5	78.8	72.5
148-169	...	83.7	73.8	67.7
176-197	...	82.3	82.4	63.9
204-225	...	76.9	69.1	61.6

In each of the four periods the percentage of flush shoots in the crop obtained from the cut-across bushes was less than that from clean or lung-pruned bushes. It was also found that the percentage of flush in the crop harvested from the cut-across bushes during the eight plucking rounds prior to the other series coming into plucking showed marked fluctuation. The first two rounds yielded mainly banji shoots, the percentage of flush being only 35.6 per cent, but in the third and fourth rounds it rose to 84.3 per cent. It then fell to 36.8 per cent in the seventh and eighth round, recovering thereafter to the values given in the table above. Practical experience has shown that, in the case of a high cut-across, it is necessary to deal effectively with the large amounts of banji produced in the first few rounds if loss in crop is to be avoided. It is not desirable, however, at low elevations, to strip banji below the surface of the plucking table, owing to the importance of maintaining as large a leaf area as possible in the early part of the cycle.

The percentage of flush in the first round of plucking was also found to be low in the case of cut-across bushes at an elevation of 4,600 feet

which were pruned at the same height as the other treatments. The percentage of flush in the yields were, lung-pruned, 87.2 per cent, clean-pruned 88.5 per cent and cut-across 75.7 per cent. The changes that occur in the shoots composing the crop during the cycle are now under detailed examination.

Publications.—The change in the general direction of research in the Department, together with the completion of the first cycle, the St. Coombs pruning experiments rendered it desirable to collate the information derived from the various experiments undertaken. This has been done, and the results obtained are found in Bulletin No. 16.

Some of these results were published in the Journal of Pomology, 1936, Vol. XIV, pp. 317-46.

F. R. TUBBS.
Plant Physiologist.

REPORT

OF

THE TEA TECHNOLOGIST

FOR 1936.

Staff.—Mr. H. B. Sreerangachar, M.Sc. (Bombay), B.Sc. (Mysore), A.I.I.Sc., was appointed as Research Assistant to the Department. He assumed duties on 15th July, 1936.

Correspondence.—498 letters were received and 511 despatched. These figures show a marked increase on previous years.

Samples.—528 samples were received for determination of moisture content.

Estate Visits.—Sixteen visits to estates were made by request from the estate superintendents concerned. Five visits were made for investigational purposes.

Lectures.—The Tea Technologist gave addresses at meetings of the Sabaragamuwa, Kelani Valley and Nuwara Eliya District Planters' Associations.

Advisory.—The problems encountered in advisory work are very diverse. It must be borne in mind that advisory visits are in the majority of cases made to factories where results are unsatisfactory and where efforts by the superintendent and others to improve manufacture have not met with success. The following remarks must not therefore be interpreted as drawing a picture of the general state of affairs in Ceylon tea factories.

Incomplete organisation appears to be responsible for many of the difficulties encountered. This is particularly true of the rolling and firing rooms and in many cases is an outcome of inadequate equipment. In such cases it will be found that the firing machine either cannot cope with the output of the rolling room or that it has a much larger capacity than is necessary, with a result that long gaps and overfiring occur at intervals throughout each working day.

There are still some factories where there is not any regular system of manufacture and records are not kept, each day's manufacture being

carried out entirely at the teamaker's discretion. Judging from experience in cases where an advisory visit has been made, it is apparent that such factories are much less successful than well organised factories. In such cases where some simple system of organisation has been introduced, satisfaction is usually expressed over subsequent results.

Organisation and the keeping of factory records do not however bring about any improvements unless the organisation is actually practised and the records kept represent what is actually happening in the factory. There are so many variable factors in the process of tea manufacture, starting from variations in the nature of different pieces of flush picked from the same bush, that a variation of 0.01 per cent in day-to-day figures as actually written up in factory record books in some cases brought to notice, cannot but excite suspicion that the record book is one of aims and objects and not of actual practice.

The question of adequate supervision must therefore be considered. Since the acreage in the charge of the average superintendent is showing a distinct tendency, on the whole, to increase, it is often not feasible for superintendents to spend more time in the factory. Manufacturing programmes which are easy to check whenever the superintendent may enter the factory are, therefore, becoming an absolute necessity.

Fortunately, this aspect of manufacture has been intensively studied recently by Mr. F. R. Francillon and Mr. Burnett with the assistance of Mr. F. J. Whitehead. Their results have been described by Mr. Whitehead in his paper on Factory Organisation at the January, 1937 Conference which appears in *The Tea Quarterly,* Part I, Vol. X, 1937.

This paper is worthy of the most careful study since it presents an entirely *new* aspect of factory control and offers a solution to an ever increasing difficulty. The basic principle of this method is to organise manufacture according to a plan based on firing and rolling room capacities, in such a way that all operations are synchronised. Any deviation from the programme due to negligence on the part of the factory staff will at once become apparent to the superintendent, whenever it is convenient for him to call in at the factory.

Other devices of considerable utility are described in a paper by Mr. G. K. Newton in *The Tea Quarterly,* December, 1936, page 199.

Green leaf sifting and the consequent advent of very fine dhools is raising new firing problems. These very fine dhools sifted through 10 and 12-mesh act like a blanket in a tea drier, to such an extent that the air flow is damped down enough to cause a rise in inlet temperature and even a fall in exhaust temperature sufficient to cause soft teas to be made. If firing of the coarser leaf is attempted on the same setting of the spreader,

the increased flow of air will result in a fall of inlet temperature and a rise in exhaust temperature to undesirable heights.

Apart from these considerations, very fine dhool is most liable to be blown off the top tray of an automatic drier in excessive quantities if the velocity of the air flow through the drier is at all high. Fan valve adjustments then become necessary.

Firing on a set spreader position is, under ordinary conditions, liable to cause variation in the firing of different dhools, but when a system of green leaf sifting is adopted it becomes very undesirable if not impracticable.

In addition to spreader adjustments, fan valve adjustments may also be necessary between the firing of very fine and coarser dhools. A study of firing conditions in each individual case is therefore necessary before arranging any definite programme of manufacture. Attention is drawn to *The Tea Quarterly,* Part I, 1935, page 43, in this connection.

ANALYTICAL.

Ash Contents.—The food and drug regulations of various countries specify limits for the total and soluble ash contents of tea. The purpose of these limits is mainly to :—

(a) detect mineral adulteration which would cause high ash contents,

(b) detect adulteration by redried spent leaves either due to intent to defraud or damage by water. In such cases the ash contents would be low, especially the soluble ash content.

TABLE I

	% Ash Content	
	Total	Soluble
Nuwara Eliya District B. O. P.	4·88	3·21
Dimbula ,, B. O. P.	5·27	3·32
,, ,, B. O. P.	5·41	3·30
,, ,, O.P.	5·95	3·62
Dickoya ,,	5·22	3·33
,, ,,	5·07	3·40
Kelani Valley B. O. P.	5·47	3·62
,, ,, O. P.	6·46	4·37

Normal Ceylon teas gave the results shown in Table I. These figures indicate the normal range of ash contents of Ceylon teas. Ash content appears from these figures to vary inversely with elevation. The ash

content of stalk appears to be markedly higher than that of the corresponding leaf, judging from the differences between the comparable B.O.P's and O.P's.

Miscellaneous Analyses.—A deposit from a roller cap consisting of a hard greyish substance, resembling concrete, was sent in for examination. It was feared that the roller cap had, in the past, been treated with some material which was flaking off and finding its way into the tea. On examination this material proved to consist of 30 per cent of inorganic salts, mainly iron and phosphates with manganese and traces of several other elements. The deposit was evidently derived from juices which had dried on the roller cap and eventually arrived at a state resembling petrification.

Several paints were examined for lead. All paint samples stated to be lead-free were found to contain traces only of lead and were therefore suitable for use in tea factories.

A parcel of sheets of aluminium foil with small areas of corrosion on both surfaces was sent in for examination and report. The corrosion appeared to be due to splashes of some caustic substance. Analyses of the foil, which was of British origin, proved it to be 99.7 per cent aluminium with minute traces of other elements such as iron.

BIOCHEMICAL.

The addition of a qualified biochemical assistant to the staff allowed an expansion of the programme of biochemical work carried out in the department.

Enzymic Fermentation.—Although it is now recognised that enzymes play a considerable part in fermentation, the action of these enzymes has not so far been fully studied. Investigation was therefore started with a view to developing a quantitative method of estimating the activity of the principal oxidising enzyme and to applying this technique later on to a study of problems relating to manufacture and storage of tea.

Method of Estimation.—It is necessary for this purpose to obtain on the one hand a suitable enzyme preparation free, as far as possible, from tannin and, on the other, a substrate solution free from the corresponding enzyme. By treating the samples with acetone and then drying the material over calcium chloride in a vacuum desiccator, dry powders are obtained containing the active enzyme but relatively poor in tannin. The latter, however, is corrected for in an actual experiment. The enzyme is extracted from these dry powders by means of a suitable buffer solution.

The substrate is prepared by immersing the fresh leaf for 5 minutes in boiling water, obtaining the press juice and diluting it as desired. When preserved in the dark the solution keeps for about a fortnight.

By titrating iodometrically the amount of theo-tannin present in an aliquot of the reaction mixture before and after the action of the enzyme, it has been possible to estimate the enzyme activity of any given sample. The reaction is carried out in a suitable flask through which a gentle stream of air is bubbled, the flask itself being suspended in a thermostat maintained electrically at a constant temperature.

Kinetics of Enzyme Action.—The kinetics of the enzyme action have been studied by drawing out aliquots of the reaction mixture at different intervals of time and determining the enzyme activity at the end of these intervals. The time graph thus obtained corresponds to the usual characteristic enzyme curve.

Effects of pH.—In an attempt to determine the effect of pH on the activity of this enzyme preparation, systems maintained at definite pH values by Mclaivan's buffer were investigated.

pH.	Enzyme Activity in 1g dry powder ml. Thio. N/20.
5.0	31.2
6.0	32.4
7.0	46.8
8.0	61.4

The activity of the enzyme increases between the values pH.4.0 to pH.7.0 while at definite alkaline reactions there is spontaneous oxidation of the tannin which vitiates the actual measurement of the enzyme activity. This spontaneous oxidation is characterised by the development of a black colour in the medium.

Effect of Temperature.—As in other enzyme reactions temperature has a considerable influence over the activity of this enzyme. As shown in Fig. I the optimum temperature is in the region of 120°F. The enzyme in solution seems to possess very little activity at the temperature of boiling water.

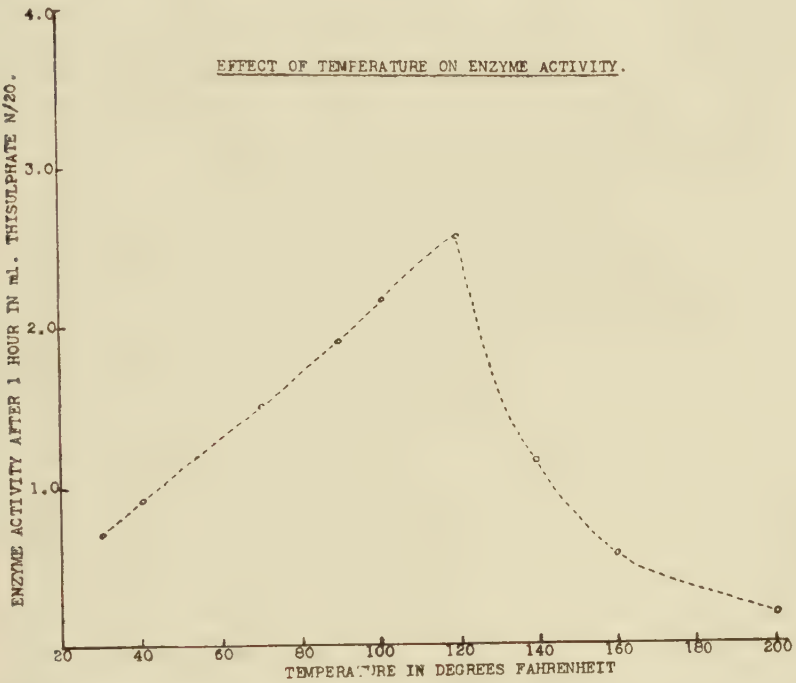
Applications.—A preliminary study of the enzyme activity of the tea leaf during different stages of manufacture has shown wide fluctuations. During withering there is an appreciable increase in the enzyme activity, which remains practically the same during rolling, decreases slightly during fermentation, and diminishes greatly thereafter while firing. It is noticed, however, that the enzyme is not completely inactivated in the process of firing.

The course of destruction of the enzymes during firing has been further followed by taking samples from different trays in the St. Coombs factory drier and estimating their potential enzyme activity.

Samples	Enzyme activity in mls. Thio N/20	
	Experiment No. 1	Experiment No. 2
1. At feed.	18·6	15·9
2. At the end of 3rd row	14·5	11·75
3. ,, ,, ,, ,, 4th row	13.4	10·4
4. At discharge	7·2	6·6

It is apparent from these results that made tea still contains an appreciable quantity of enzyme which might have a considerable effect on its keeping qualities. Further investigations on this enzyme are in progress.

FIG I



Chemical Composition and Quality.

The Effect of Age from Pruning on Composition.—The department is indebted to Dr. F. R. Tubbs for the material on which these analyses were carried out. Other data relating to weights, etc., of the various components of the whole flush will be found in Bulletin No. 15. From the results given in Table II it will be observed that age from pruning has a marked effect upon the composition of the components of the flush. The first leaf and internode are the richest parts of the flush in theo-tannin whilst the buds or tips are relatively poor in both soluble matter and theo-tannin.

TABLE II

Sample	Age from pruning	% Water soluble material (Calculated on dry matter)	Total oxidisable material per 1.0 gm. of dry tea	% Content of soluble theo-tannin derivatives (Calculated on dry matter)
Buds	5 months	42·5	207	—
1st Internodes	5 ,,	45·0	225	18·22
1st Leaf	5 ,,	45·5	253	24·20
2nd Internodes	5 ,,	49·4	214	—
2nd Leaf	5 ,,	42·1	228	20·32
Buds	48½ ,,	44·2	261	23·61
1st Internodes	48½ ,,	47·8	290	28·26
1st Leaf	48½ ,,	51·2	316	31·83
2nd Internodes	48½ ,,	49·9	256	25·30
2nd Leaf	48½ ,,	48·6	303	29·98

These latter observations are supported by the following figures :—

*The Effect of Nitrogenous Manuring on Composition.**—Three levels of nitrogenous manuring were investigated viz :—

2 (N) = 40 lbs. nitrogen per acre.
1 (N) = 20 ,, ,, ,, ,,
0 (N) = Plots did not receive any applied nitrogen.

TABLE III

Sample	% Water soluble material (Calculated on dry matter)	Total oxidiasble material per 1·0 gm. of dry tea	% Content of soluble theo-tannin derivatives (Calculated on dry matter)
Buds 0 (N)	45·6	264	26·2
Buds 1 (N)	44·6	254	24·8
Buds 2 (N)	43·2	243	22·6
1st Leaf 0 (N)	48·2	296	29·3
1st Leaf 1 (N)	48·3	294	28·9
1st Leaf 2 (N)	47·4	276	28·4
2nd Leaf 0 (N)	45·8	273	27·8
2nd Leaf 1 (N)	45·4	269	27·8
2nd Leaf 2 (N)	46·2	263	25·4
1st Internodes 0 (N)	49·3	292	29·1
1st Internodes 1 (N)	45·7	264	26·4
1st Internodes 2 (N)	46·0	257	25·2
2nd Internodes 0 (N)	48·2	244	25·8
2nd Internodes 1 (N)	48·3	238	25·2
2nd Internodes 2 (N)	47·9	232	23·8

* Analyses of flush supplied by Dr. Tubbs from Dr. Eden's Manurial Plots.

From the results given in Table III it will be seen that there is a tendency for the higher levels of nitrogenous manuring to depress the tannin content and to some extent the percentage of water soluble material in the various components. As will be shown later, however, this has not affected the valuations of the teas.

The Effect of Banji Formation on Composition.—Although the results given in Table IV are not strictly comparable with those given in the previous tables, they serve to demonstrate that banji leaf is by no means lacking in soluble matter and theo-tannin.

TABLE IV

Sample	% Water soluble material	Total oxidisable material	% Content of soluble theo-tannin
Single banji 1st Leaf	48·5	307	31·6
Double ,, 1st ,,	47·8	299	30·3
Double ,, 2nd ,,	46·0	281	28·8

The Effect of Age from Pruning on Quality.—The figures given above confirm observations made in 1934 when I found a large rise in the tannin content of made tea with age from pruning. Associated with this were increases in the valuations. I stated in my annual report for that year that there was an indication of a fall in tannin content at the end of the pruning cycle.

More recently I have had the opportunity of doing experimental manufacture at St. Coombs on leaf from an estate on which certain fields were successfully run as long as 70 months. In this connection our thanks are due to the Nuwara Eliya Tea Estates Co. for giving us the leaf for these experiments and to Mr. E. C. Elliott for his ready co-operation.

The data obtained from this latter experiment did not show any fall, even at the end of the very long cycle.

As indicated in Table V, tests over four consecutive months showed an increase in the tannin content of the 70 months old leaf amounting to 6 per cent of that of 16 months leaf. Associated with this increase in tannin content was an increase also in value, amounting to 6 per cent in Colombo valuations and 9 per cent in London valuations. Between 16 and 40 months old leaf the increase in theo-tannin was 3.6 per cent, and in valuation, 3 and 3.5 per cent in Colombo and London respectively.

Leaf from Dr. Tubbs' pruning experiment manufactured in this department and sent to the tasters, showed over a period of 13 months,

TABLE V

Age in months	Percentage increase in		
	Theo-tannin	Colombo valuations	London valuations
16:70	6·0	6·0	9·0
16:40	3·6	3·0	3·5

the results given in Table VI, where a cross indicates a significant difference in favour of the older tea.

TABLE VI

X indicates significant difference in favour of older tea.

Age in months	Taster	Colour	Strength	Pungency	Quality	Flavour	Valuation
	A						Not valued
38:42	B	X		X	X	X	Not valued
	C						X (0·8 cts.)
	A		X		X	X	Not valued
38:42	B			X	X	X	Not valued
	C						X (1·4 cts.)

No significant difference in favour of the younger tea was found. The interesting point arises that effects are detectable due to a difference of only four months at the end of the cycle. It thus appears that at this elevation the increase in the value of the made tea has not ceased even in the fourth year.

The Effect of Nitrogenous Manuring on Quality.—Eight manufactures of leaf from the plots manured with 40 lbs. nitrogen per acre and from

the plots which do not receive nitrogen, carried out during the period October, 1935 to October, 1936 gave the following results.

Average values of eight manufactures.

Colombo (Rupee cents)		London (Pence)	
40 lbs. nitrogen	No nitrogen	40 lbs. Nitrogen	No nitrogen
70	69·5	17	17
(Valuations based on arbitrary standard)		(Valuations based on market)	

It will be seen from these figures that during 1936 the tasters could not detect any differences between the teas made from plots receiving 40 lbs. nitrogen per acre and those plots which did not receive any added nitrogen. This experiment will continue for some time; the final conclusion reached may be at variance with the results obtained during 1936.

It is of interest to note that in spite of the higher contents of soluble matter and theo-tannin in the samples analysed, the teas made over the course of one year have not shown any difference. This is contradictory to the results from the pruning experiments where in seven manufactures carried out at intervals during a period of four months the valuations followed closely on the theo-tannin contents. The significance of these indications is not understood but is being investigated further.

The Effect of Banji Formation on Quality.—Sufficient banji leaf to charge one experimental roller was collected and manufactured under conditions identical with the manufacture of normal flush. Samples sent to Colombo and London were reported on as follows :—

Colombo (Rupee cents)		London (Pence)	
Normal	Banji	Normal	Banji
70	69	15	14

This result is not surprising when the analysis of banji leaves is taken into account. It is however contrary to the popular idea that banji leaf makes very poor tea.

Conclusion.—The above results are only an interim report on what promises to be a long investigation. It is evident that although the percentage of soluble matter and the theo-tannin content of Ceylon teas are in some way related to quality, they are not the only factors which govern the quality of made tea.

GENERAL MANUFACTURE.

Withering.—Investigations of the withering process have been mainly confined to the laboratory. The behaviour of individual pieces of flush have been studied in the apparatus described in the Annual Report 1935, page 71. The apparatus is illustrated diagrammatically in Fig. II.

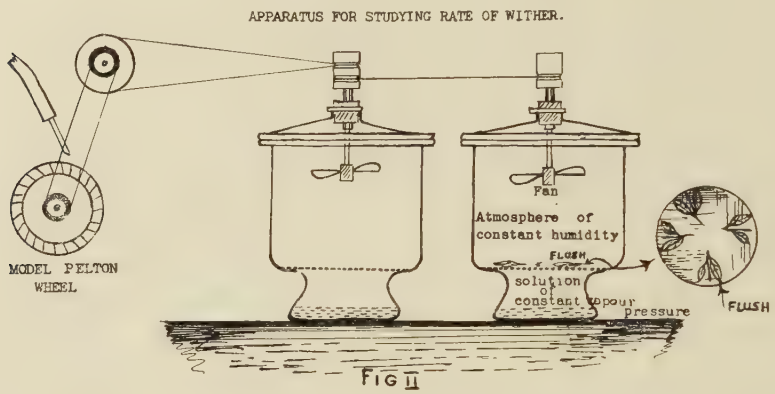


FIG II

The homogeneity of conditions in the apparatus was tested by measuring the loss by evaporation from six small basins of water, placed in the same marked and numbered positions as would be occupied by pieces of flush under test.

Per cent Relative Humidity in Desiccator = 51.

No. of basin	Weight of water	% Loss after 16 hrs.	% Loss after 20 hrs.
1	5·94	47	59
2	5·97	48	63
3	5·96	46	60
4	5·95	47	60
5	5·93	44	58
6	5·96	44	57

The basins were all 30 ml. capacity but not specially selected for uniformity.

Large variations have been found in the rate of wither of different pieces of flush picked from the same bush. These variations become more marked when the moisture content of the flush has fallen below 65 per cent.

High and low humidity conditions, high and low rate of air flow over the leaf appear to have little effect upon the evenness of wither. Large variations have also been found between different pieces of flush picked from one bush whether of high or low jât, recently pruned, or a bush at

the end of its pruning cycle. Pieces of flush gathered from the outer branches of a bush have been found to vary as much as pieces picked from the inner branches of a bush.

Exposure of the under surface of the leaves on a piece of flush in comparison to flush turned the opposite way has not revealed any differences.

Throughout the experiments great care has been taken to avoid bruising the flush and each piece has been carefully plucked, leaving a leaf between the flush removed and the fish leaf. There appears to be some relation between size of flush and rate of wither, since small pieces frequently become brittle before the larger pieces are half withered, but other factors must exercise some effect since this relation is not invariable as Table VII shows.

TABLE VII

Buds and Two Leaves used in all Experiments.

Large Flush						Small Flush					
Fresh weight gms.	% Moisture in fresh leaf	% Moisture after withering for:— 4 Hours	7 Hours	21 Hours	26 Hours	Fresh weight gms.	% Moisture in fresh leaf	% Moisture after withering for:— 4 Hours	7 Hours	21 Hours	26 Hours
0·886	79	75	73	61	62	0·132	74	65	60	39	28
0·893	78	74	71	62	51	0·300	76	72	70	64	60
0 693	77	74	72	67	64	0·316	77	71	69	58	53
0·631	78	74	73	67	64	0·263	76	70	67	58	54
0 595	77	74	72	66	62	0·359	77	73	71	62	57
0·576	77	73	71	62	57	0·427	77	74	72	68	65

The weight of water evaporated does not bear any relation to the dry matter in the flush as the results given in Table VIII show.

After studying the figures in Table VIII one is forced to the conclusion that factors other than purely physical factors govern the rate of loss of moisture from flush during withering.

This investigation will be continued and improvements in the apparatus are envisaged as a result of discussion with Dr. Hoedt, Director of the Proefstation West Java.

The Practical Bearing of the Withering Investigation.—Even withering is aimed at in most factories and a good deal of work has been devoted to maintaining a consistent average figure. In spite of the large variations liable to occur between individual pieces of flush, a fairly consistent average figure may in practice be arrived at from day to day.

TABLE VIII

Fresh weight gms.	% Moisture in fresh flush	% Moisture after withering	Wt. of dry matter gms.	Wt. of water per unit of dry matter	Wt. of water evaporated	Ratio wt. of water evaporated to wt. of dry matter	Ratio wt. of water evaporated to wt. of water per unit of dry matter
0·803	80	62	0·16	3·99	0·38	2·4	9·6
0·774	80	67	0·16	4·00	0·29	1·9	7·3
0·716	79	65	0·15	3·77	0·29	1·9	7·7
0·587	79	59	0·12	3·78	0·29	2·3	7·6
0 527	79	63	0·11	3·75	0·22	2·0	6·0
0·682	79	63	0·14	3·77	0·30	2·1	8·0
0·839	78	62	0·19	3·54	0·37	2·0	10·4
0·424	78	52	0·09	3·56	0·23	2·5	6·6

It is quite possible that a certain technique of withering may enable us to minimise the variation between individual pieces of flush. For instance, it has been shown that wide variations do not occur until the moisture content of the withering leaf has been reduced below 65 per cent. Beyond this point very slow withering will prevent any particular individuals from withering too rapidly because the pressure of water vapour in the atmosphere is too high to allow rapid evaporation. Thus if the mechanism of withering is studied first we shall eventually be in a stronger position to investigate withering technique on a commercial scale.

A semi-commercial, air-conditioned withering installation has been erected in St. Coombs factory to supplement laboratory work. Meanwhile it is of interest to study the present conditions obtaining in practice.

A handful of factory leaf gathered from a small area of tat at the end of what appeared to the practical eye to be an even wither gave the following results :—

	Per cent Moisture
1	43
2	67
3	62
4	39
5	64
6	62
7	68
8	57
9	47
10	43
11	53
12	61
Average	55.5

The average, viz. 55.5 per cent moisture, was very close to the figure obtained day after day for bulked leaf taken over from the commercial side of St. Coombs factory and used in rolling experiments.

TABLE IX

ANALYSES OF RANDOM SAMPLES.

Withered leaf at knocking down			Bulk at end of 1st roll			Bulk at end of 4th roll	
Sample	Fresh wt.	% Moisture	Sample	Fresh Weight	% Moisture	Fresh Weight	% Moisture
	·411	63		·204	54	·090	59
Bud and	·847	62	Shoot	·071	59	·018	50
2 leaves	·340	61		·514	58	·036	55
	·532	68		·284	56	·048	50
		Av.= 63			Av.= 57	·050	58
	·155	53		·143	56	·032	50
	·339	67		·103	59	·040	55
Banji	·275	63	Leaf	·133	53	·036	50
	·272	54				·032	53
		Av.= 59			Av.= 56	·043	56
	·111	41		·123	68		
Single	·374	57	Stalk	·057	60		
leaves	·106	57		·079	62		
	·104	45			Av.= 63		
		Av.= 50					
Average		57			59		54

A careful study of individual pieces of flush during rolling has not revealed any marked difference of behaviour in the way in which the flush twists and separates into dhools. It is possible that variations in moisture content are not harmful. On the other hand variations in moisture content may cause mixed infusions at a later stage due to differences in the rate of fermentation.

TABLE X.

1st Dhool (Passing 6-Mesh)		4th Dhool (Passing 6-Mesh)	
Fresh weight	% Moisture	Fresh weight	% Moisture
·010	50	·012	58
·010	50	·008	50
·007	57	·019	53
·018	55	·006	50
·010	40	·008	50
·013	54	·015	53
·012	58	·007	57
·023	65	·025	56
·010	50	·018	56
·014	50	·004	50

A detailed investigation of the history of single pieces of flush, bulk and dhool is therefore called for since it is possible that moisture contents may be evened up during the rolling process. Only preliminary results are available, and these are set out in Tables IX and X.

It is evident from the above figures that rolling does not even out the differences in moisture content of the individual pieces of flush. In so far as each whole shoot is concerned it will however exercise a bulking effect.

Determination of the Moisture Content of Withered Leaf.—The apparatus described in the Annual Report, 1934, page 57, has been developed by modification of a combined fan and heater used by dyeing chemists to supply hot air for the rapid drying of test materials. This apparatus will enable moisture content determination to be carried out in 15 minutes. It is also applicable to made tea. The apparatus may be placed on the market during 1937.

Rolling.—Further to the work on standardisation of our experimental rollers reported last year, comparisons of the performance of an experimental roller with a full sized roller have been carried out. In these

experiments a table which was a copy of the commercial sized table was used in the experimental roller. Both rollers worked at the same speed and the pressure applied (in lbs. weight) per pound of leaf charged into the roller was as nearly as possible the same in both cases.

Under these conditions, the dhool out-turn and the power absorbed in rolling proved to be comparable. Samples of fired tea were sent to both Colombo and London tasters and in neither case was any sharp distinction drawn between the comparative samples. It is evident therefore that the experimental rollers are fully comparable with commercial rollers.

TABLE XI

Showing out-turn and valuations of B.O.P. of Dhools 1 to 3 rolled under identical conditions of speed and pressure.

Date	Battens	% Moisture in withered leaf	% Out-turn of dhools 1—3	Valuation of B. O. P.	
				Colombo	London
3-9-36	Type X	59·3	46·5	78 cts.	15¼ pence
	Type Y	59·3	34·0	77 ,,	16¼ ,,
	Type Z	59·3	27·3	80 ,,	17 ,,
15-9-36	Type X	56·4	47·7	78 ,,	17½ ,,
	Type Y	56·4	33·0	81 ,,	19 ,,
	Type Z	56·4	24·9	87 ,,	20½ ,,

An investigation of the effect of the form of roller batten upon rolling performance was also carried on during 1936. Progress with each particular problem has been checked by the necessity for the investigation of a number of subsidiary problems raised. As the results obtained have not yet been applied on a commercial scale, it is advisable to abstain from connecting the names of the battens employed with these results, and on this account the batten types are purposely designated as types X, Y and Z. Without prejudice to this object it can be said that these battens corresponded very closely to the general forms of roller tables associated with the names, Reeves, Jackson's and Lamont-Michie. A programme of four rolling periods with gradually increasing pressure was adopted in these experiments and the B.O.P. taken from the first three dhools was sent to the tasters. As shown in Table XI, one type, namely, X battens proved to be the most efficient from the mechanical point of view, followed by Type Y, and Type Z.

That is to say, for a given consumption of power, Type X battens turned out more dhool than Type Y, and Type Y more than Type Z. The Type X battens turned out almost twice as much dhool as Type Z battens per unit of power consumed. When the resultant teas went to the tasters, those from Type Z battens, were valued well above those from Type X battens, with Type Y again occupying an intermediate position. Thus there was an inverse relationship between dhool out-turn and price. As shown in Table XII differences in valuation sometimes amounted to as much as 3 pence per pound.

TABLE XII

Analytical Specification.

Group Opinion of London Tasters on Characteristics of teas as given in above Table.

Date	Number	Appearance	Colour	Strength	Flavour	Quality	Pungency	Valuation
3-9-36	Type X		TO BE TAKEN AS STANDARD					15¼ d.
	Type Y	S.	S.B.	S.B.	E.	S.B.	S.B.	16¼ d.
	Type Z	M.S.	S.W.	S.W.	S.B.	S.	S.	17 d.
15-9-36	Type X		TO BE TAKEN AS STANDARD					17½ d.
	Type Y	S.	S.B.	S.B.	S.B.	A.B.	A.B.	19 d.
	Type Z	V.M.S.	S.W.	S.W.	S.	S.	S.	20½ d.

Explanation of symbols :—

(A) Marking up above the standard.
1. Slightly better (S.B.)
2. Appreciably better (A.B.)
3. Superior (S.)
4. Much superior (M.S.)
5. Very much superior (V.M.S.)

(B) Equal — Symbol (E).

(C) Marking down below the standard.
1. Slightly worse (S.W.)
2. Appreciably worse (A.W.)
3. Inferior (I.)
4. Much inferior (M.I.)
5. Very much inferior (V.M.I.)

In every case the B.O.P's from the teas on the Type Z battens were preferred on appearance to teas made on both the other battens. The colour and strength of Type Z teas were inferior to both Type Y and Type X, but quality, flavour and pungency, if present, were superior.

The value of detailed specification of teas from an experiment of this sort is demonstrated very clearly when there happens to be a strong market for tip. On these occasions the value of tippy teas appreciates out of all proportion to their superiority in quality and flavour while their colour and strength may be definitely inferior to the less tippy teas. In a series of experiments lasting from June to December there has scarcely been a single exception to the findings described above. The minimum difference in Colombo values between teas from these experiments was 1 cent and the maximum 9 cents. In London the minimum difference was 3 farthings and the maximum 3 pence. Throughout all these experiments the ratio of the dhool out-turns between battens was practically constant and of the order given in Table XI.

Although the Type Z B.O.P's are invariably valued highest they are derived from a lower percentage of the bulk and it is now necessary to get valuations for all the grades and to estimate the price realised by the whole charge of tea rolled in each type of batten.

An interesting question is raised by these experiments and is concerned with the extra power absorbed (per pound of dhool turned out) on Type Z battens as compared to Type X. Is the extra energy needed by these battens just wasted, or is it absorbed in extra rolling of the leaf thereby making better teas ? If we pursued we could devise a knife batten which would give us a very high dhool out-turn for a very small expenditure of energy, in other words, just chop the leaf up. Thus there must be a limit with every type of batten to the amount of dhool it is *desirable* to turn out.

Examination of the leaf taken at the end of the first roll by soaking and untwisting the bulk as described in the Annual Report, 1935, page 71, reveals the type of action which is proceeding in the roller. With Type Z battens only the bud and top portion of the first leaf will be found to be missing from the flush in the majority of pieces picked out. If hard pressure is applied, or if a more severe type of batten is employed, it will be observed that much more breaking up of flush has occurred. Theoretically, at any rate, there is a great deal to be said for division of leaf in the roller by twisting instead of by cutting and tearing. Just how far this ideal is possible even with the best type of batten depends on several factors, and it occurred to us that unevenness in the withered leaf would be an important consideration. We have found that withered leaf brought down from a factory loft does not by any means consist of evenly withered leaf. The average of a number of withered pieces of flush may be fairly

constant from day to day, or from loft to loft, or even tat to tat, but the *individual* pieces of flush will be found to vary as in the example given in the section of this report devoted to withering.

Effect of Type of Leaf and Percentage Average Wither on Dhool Out-turn.—During all rolling experiments records have been kept of the type of leaf and the moisture content of samples of bulked leaf. This has afforded an opportunity for statistical analysis of the effects of these two factors upon dhool out-turn. From the data collected during 1936 it is evident that type of leaf has not affected dhool to a significant extent.

In these experiments average withers have varied to the extent of 4 per cent from mean. These variations do not appear to have affected dhool out-turn to any marked extent. Whether, or not, variations in the moisture contents of the *individual* pieces of withered flush affect the twisting and dividing of some of them, thus preventing effective separation of fine parts from coarse parts during the rolling, remains to be worked out in detail, but it appears at the present moment that the behaviour of the various pieces of flush, in so far as being twisted and divided into dhools is concerned, is fairly uniform.

Speed of Rolling.—In the last annual report a short account of the effect of speed of rolling on dhool out-turn was given. One roller was run at 50 r.p.m. and another at 76 r.p.m. and the pressures were so adjusted as to cause equal amounts of power to be absorbed in the two rollers. Battens of the Reeves type were used on both tables. Under these conditions the slow moving roller gave a better dhool out-turn than the fast moving roller. This experiment has been repeated with a modification, namely that equal pressures were applied, and the resultant dhools were fired and sent to the tasters.

The following results were obtained :—

Dhool	% Dhool out-turn	
	50 R.P.M.	78 R.P.M.
1	14	20
2	24	33
3	30	28
Bulk	32	19

The average power consumption during the pressure periods was 5.9 kilowatts in the fast moving roller and 4.0 in the slow moving roller. The difference when the pressure was taken off was only 0.03 kilowatts at 0.5 kilowatts.

Valuations (B.O.P. only).

Colombo (Rupee cents)		London (Pence)	
50 R.P.M.	78 R.P.M.	50 R.P.M.	78 R.P.M.
68·5	65·5	15	14

The appearances of the tea from the slow moving roller were reported to be better and more tippy while the infusions were brighter, more even and coppery.

These results must not be taken as conclusive evidence until a number of experiments over all seasons have been carried out and the prices realised by the whole charges of leaf rolled under these different conditions have been estimated.

Conclusive indications of marked effects due to difference of speed in rolling have however been obtained from these experiments as far as they have gone.

Conclusion.—During 1936 conclusive indications of marked effects due to differences in batten type and speed have been obtained from the rolling experiments. Further work is desirable to interpret these findings and assess their commercial value.

Firing.—The machines described in the last annual report have both been installed.

Tests with the 3 ft. Empire Drier have not been completed but the machine has given a very satisfactory performance without mechanical trouble. In daily use with the fan valve $\frac{3}{4}$ open (*i.e.*, working below maximum capacity) it has given an out-turn of 160-170 lbs. per hour of tea fired to 3-4 per cent moisture content in 21 minutes, working on fermented leaf with average moisture content 55-58 per cent. The normal inlet temperature employed is 195°F. and the exhaust temperature is maintained as near as possible to 125°F. Under these conditions the *addapu* dhool averages to 2.6 per cent of the total fired tea and is discharged automatically every 2 minutes. The moisture content of the *addapu* dhool averages 3.3 per cent.

Working at the rate of out-turn of fired tea given above the blow-out amounts to 0.9 per cent of the weight of fermented leaf fed to the machine and consists almost entirely of fibre and open flat leaf. Under these circumstances the blow-out is advantageous. Lighting up the stove consumes 260 lbs. of firewood at 800 lbs. per yard.

With regard to tea fired per unit of fuel, it is difficult to give a figure until a test on a long day's run has been completed, with the machine running at maximum output. On an average day with the machine working below its maximum output there is no difficulty in firing a pound of tea with 1.2 lb. of the firewood specified above. This figure is exclusive of the cost of lighting up. The inclusive figure is obviously influenced to a much larger extent by the cost of lighting up in a short working day than on a long working day and is therefore a highly misleading figure.

With short crop there has not been any difficulty in reducing the output of the drier to 110 lbs. per hour. This is a most important consideration on a small estate with only one drier and has obviously been overlooked in choosing the size of firing machine in many Ceylon factories. Several cases have come to notice in the past where a firing machine has been installed with the object of catering for rush crops, future possible increases of crop and then a margin for safety allowed. With the advent of restriction and short crops these machines are very difficult to adapt to all circumstances arising during the year's work. From this point of view a number of small units in any part of a tea factory possesses considerable advantage over a large unit.

The 3 ft. Empire Drier has also been successfully adapted to the firing of the 10-mesh and 8-mesh grades of dhools from the green leaf sifter.

The installation of a short 3 ft. E.C.P., the first of its kind, has just been completed. This machine is fully automatic and has a smaller capacity than the 3 ft. machine in order to make it equivalent in size to a tilting tray machine.

The short 3 ft. E.C.P. therefore has all the advantages of a fully automatic drier whilst being designed to fire a small crop with the maximum efficiency. Induced draught has been fitted to the furnace of this new machine and will enable us to compare the efficiency of induced draught as against natural draught on the air heater of a tea drier. It is hoped that full tests will be carried out with the machine during 1937.

The experimental drier described in the last annual report has also just been installed. This machine has been designed purely for experimental convenience and it is hoped that it will be fully adapted to our needs within the next month or so. Preliminary tests have been fully up to expectations and we hope to answer a number of urgent firing problems without having to multiply the number of experiments to a very large and unwieldy extent in order to avoid complication due to difference in dhool number and length of fermentation.

The drying chamber was constructed for us by the Colombo Commercial Co., Ltd., and we are much indebted to Mr. Salmon for the assistance he gave us in giving practical form to our suggestions. The

heating units were imported from England on specifications kindly prepared for us by Mr. W. F. A. Ridler of Messrs. Marshall's Tea Machinery Co.

Fuel Tests.—A full account of these tests has been published in *The Tea Quarterly* during 1936. A ready reckoner enabling a comparison of the costs of fuels under different circumstances in various parts of the Island was calculated and included in Part IV. A suggestion that local fuel growing industry would repay more attention was put forward. Tests with induced draught and also coal and coke mixtures are planned for 1937.

Grading.

Stamped Aluminium Hand Sieves.—The sieving performances of stamped aluminium hand sieves of mesh 3 mm., 2mm. and 1 mm. were compared against the nearest corresponding sizes of brass weave hand sieves. The results are set out in Table XIII.

TABLE XIII

Stamped aluminium	Nearest corresponding size of brass weave	COMPARATIVE SIZE		COMPARATIVE SPEED	
		Weight of sievings from a uniform sample sieved until no more passed through		Weight of sievings from a uniform sample passed in a limited time	
		Brass Weave	Stamped Alum.	Brass Weave	Stamped Alum.
3 mm.	No. 8	10 lbs.	10·05 lbs.	10 lbs.	11·6 lbs.
2 mm.	No. 10	10 lbs.	9·3 lbs.	10 lbs.	8·0 lbs.
1 mm.	No. 18	10 lbs.	9·4 lbs.	10 lbs.	9·0 lbs.
4 mm.	No. 6	Too large for St. Coombs Black Tea			

Stamped Aluminium Sheets—of 2, 3 and 1 mm. mesh were tested on the Walker's Michie Sifter at St. Coombs. The following table records their sieving performance in relation to the brass weave.

The faster rate of feed in compensation for oversize perforations gives the same weight of sievings from the 3 mm. stamped aluminium as in 10 brass weave.

TABLE XIV

Sieve	Mesh	Rate of Feed	Average weight of sievings from a standard weight of a uniform sample of tea
Brass weave	10	Normal	10 lbs.
,, ,,	8	,,	12·6 ,,
Stamped aluminium	2 mm.	,,	5·4 ,,
,, ,,	3 mm.	,,	11·2 ,,
,, ,,	3 mm.	4 times normal	9·7 ,,
Brass weave	20	Normal	10·0 ,,
,, ,,	18	,,	14·8 ,,
Stamped aluminium	1 mm.	,,	13·4 ,,

Commercial Practice.—Grading is now carried out at St. Coombs on stamped aluminium and the following equivalents used:—

Stamped aluminium sheet 1 mm. = 18 – 20 mesh brass weave.

Stamped aluminium sheet 3 mm. (faster rate of feed) = 10 mesh brass weave.

The following out-turn of grades was obtained from a day's make sifted half in each (A) stamped aluminium and (B) brass weave mesh.

Grade	A New method with stamped aluminium sheeting. Percentage out-turn	B Old method with brass wire mesh. Percentage out-turn
B.O.P.	54·4	55·0
Flowery Pekoe	20·0	18·9
Orange Pekoe	5·4	6·4
Broken Pekoe	4·5	4·5
Pekoe	3·5	4·0
Fannings	8·9	8·5
Dust	1·1	1·1
Broken Mixed, etc.	2·2	1·6

Composition of Commercial Grades.—The comparative compositions ("Make") of the B.O.P., Flowery Pekoe and Fannings were determined with standard sieves, the percentage composition indicating the evenness of the composition of the individual grades from the two methods. The

component fractions given in the table below are arranged in descending order of magnitude with respect to size of particles.

I. *B.O.P.*—200 grams of tea shaken by hand in a nest of standard sieves of mesh Nos. 5, 8, 10, 12 and 16 for 4 minutes, after which time the tea was completely fractionated.

	Percentage Composition	
	A Stamped aluminium	B Brass weave
Through 5 over 8	24	19
,, 8 ,, 10	29	31
,, 10 ,, 12	22	23
,, 12 ,, 16	18	20
,, 16	7	7

II. *Flowery Pekoe.*—200 grams of tea shaken by hand in a nest of standard sieves of mesh Nos. 5, 8, and 10 for 4 minutes.

	Percentage Composition	
	A Stamped aluminium	B Brass weave
Over 5	16	14
Through 5 over 8	57	69
,, 8 ,, 10	13	8
,, 10	14	9

III. *Fannings.*—200 grams of tea shaken by hand in a nest of standard sieves of mesh Nos. 16, 20 and 30 for 10 minutes.

	Percentage Composition	
	A Stamped aluminium	B Brass weave
Over 16	22	11
Through 16 over 20	25	29
,, 20 ,, 30	39	46
,, 30	14	14

The teas from the stamped aluminium had a greater degree of blackness than those from the brass weave. Experiments are being carried out now with 2½ mm. which, the makers have recently sent out on the recommendation of the department. It is hoped that this would prove successful in improving to a great extent the composition of the larger grades.

Packing.—A number of packing materials were tested during 1936. Two special chambers each large enough to hold two chests were constructed for storage tests. The relative humidity of the atmosphere in these chambers was maintained at 90 per cent in one case and 60 per cent in the other. In every instance chests were packed on a mechanical packer.

Aluminium Foil.—A number of different gauges were tested, and found to be equal in efficiency. The most apparent disadvantage of all gauges was their tendency to tear and puncture unless very carefully made up and packed. When intact, aluminium foil makes a moisture-proof lining for a tea chest.

Lead Foil.—It was not found possible to draw any distinction between the various gauges of lead foil whether folded or soldered, and the various gauges of aluminium. The remarks on aluminium above therefore apply equally to lead foil.

Metal Foils in General.—Judging from reports received from consignees of chests of teas lined with metal foils, extensive puncturing and tearing the linings is commonly found on their arrival in London or Canada. Pieces of lining may actually become detached and mix with the tea, thus necessitating picking over and other troublesome operations. It therefore appears desirable that metal foils should be reinforced to give them the mechanical strength necessary to resist puncturing and tearing. Such materials are available and a description follows.

Reinforced Metal Foils.—In this class of material the metal foil is rolled on to a thick strong paper with an interposed film of adhesive. The metal foil used is thinner than the normal unsupported foils employed at the present moment, since its essential function is only to form a moisture proof layer over the lining fabric. When made up into a liner for a tea chest an effective seal may be made with an adhesive strip provided by the makers of the material. When used with a patent chest the lining may be used in the same way as metal foils are used at present, with the paper surface next to the chest. Squares of material forming the top and bottom of the package are then sealed in with the gummed strip. The punctures made by the staples along the seam when the strip lining the four sides is joined may be effectively sealed off with gummed aluminium tape which is now on the Ceylon market.

All trials (including shipment to London) made with this material have been very successful. There are, however, a few small points which need

attention and we propose carrying out a few further trial shipments thoroughly to confirm our results.

Rubber and Cellulose Films.—Tests with rubber and cellulose films in conjunction with Messrs. Goodyear Tyre and Rubber Co. and British Cellophane Limited are also in progress. Both of these classes of material may be heat sealed. A successful laboratory storage trial was made with a grade of rubber film called Pliofilm. Delay has occurred through difficulty in getting samples of this material. Recently it was noticed that the material with which the storage trial was conducted had aged and become brittle. Further tests in conjunction with the makers will be carried out in the near future.

General.—We are indebted to the following for assistance in our trials with packing materials :—

Messrs. George Steuart & Co.
,, Bosanquet & Skrine, Ltd.
,, Robertson, Bois & Co.
,, Thomson, Alston & Co., London.
J. F. H. Burton, Esq.
C. H. Wilkinson, Esq.

Manufacture of Leaf From Field Experiments

Manurial Experiments (in conjunction with the Agricultural Chemistry Department).—26 manufactures of leaf from field experiments concerned with the effect of manurial treatment on quality were undertaken by this department during 1936. Samples were sent to teams of tasters in Colombo and London for report. The most interesting feature of these experiments during 1936 was the tasters' preference for teas from plots receiving 40 lbs. potash per acre compared to plots which did not receive any potash. These experiments must be carried on for a further period before conclusive results will become available.

Age from Pruning (in conjunction with the Plant Physiology Department.)—7 experimental manufactures were carried out during 1936 and the samples sent for report.

Tasting of Experimental Teas.—The team system explained in the last Annual Report has given consistent and useful results during 1936. This system is commented upon in the Report of the Commission of Enquiry on the Scientific Department of the Indian Tea Association as follows :—

"Shortly after discussing quality specification with London Brokers a member of the Commission visited Ceylon. He found there, already working, a system for judging teas from experiments. It proved in

all essentials the same as that which had shaped itself in the London discussions. Ceylon, we venture to say, has made a most important advance in bringing quality under critical study. Their initial success is an incentive to other countries and their experience will be a valuable guide."

In connection with the tasting of our experimental teas it is a great pleasure to record our appreciation of the keen and able assistance given to us by the following firms :—

Messrs. Wilson Smithett & Co.
,, Geo. White & Co.
,, Forbes & Walker.
,, Harrisons & Crosfield, Ltd.
,, Whittall & Co.
,, Colombo Commercial Co., Ltd.
,, Carson & Co., Ltd.
,, Brooke Bond (Ceylon) Ltd.
,, Heath & Co.
,, Lipton, Ltd.
,, Somerville & Co.
,, George Steuart & Co.
,, E. John & Co.

We are much indebted to Mr. R. H. Horne and Mr. L. C. A. Leefe for organising the meetings of tasters in Colombo and to Mr. E. Loudon-Shand for similar services in London.

Acknowledgments:—In addition to acknowledgments made in the appropriate parts of the above report, we have once again to record our gratitude for services rendered by several planters and engineers whose whole-hearted co-operation has greatly facilitated the work of this department.

I am personally indebted to Mr. F. J. Whitehead for the continuation of his enthusiastic help and his constructive criticisms.

J. LAMB,
Tea Technologist.

REPORT

OF

THE SMALL-HOLDINGS OFFICER,

GAMPOLA, FOR 1936.

During the period under review the work done was mainly centered in one Chief Headman's Division, namely Udu-Nuwara. This was due to a competition, organised on similar lines to that held in Uda-Palata last year, amongst the small-holders in tea. 265 small-holders entered the competition. Their holdings were located in the 38 villages of this division, so the work was spread throughout the division.

Competition.—The object of the competition was to encourage the small-holder to take a keener interest in his work, to adopt the more improved methods of cultivation, and to work his holding systematically. The competition was spread over a period of 12 months to afford each competitor an opportunity of carrying out the necessary improvements according to instructions. During this period visits were paid to each competitor's holding, and advice was given as to the best methods of effecting improvements. Special attention was paid to pruning, which was usually carried out under my personal supervision.

The final judgment was based on the progress achieved during the year. Special attention was paid to the manner in which agricultural operations and soil erosion preventive measures had been carried out. Dr. C. H. Gadd, the Mycologist of the Tea Research Institute, kindly undertook the final judging this year, during the first week in November.

The distribution of prizes and certificates to the successful candidates was held at the Government Vernacular School at Eladathe on the 13th of December. We were very fortunate to have our Chairman, Mr. R. G. Coombe and Mrs. Coombe present at this function, together with the Director, Dr. R. V. Norrris. Mrs. Coombe very kindly gave away the prizes and certificates.

The Ratemahatmaya and a large gathering of small-holders were present. This prize-giving brought to a close a very successful competition from which appreciable benefits were derived by the small-holders.

The success of a competition of this nature depends entirely on the co-operation of the chief and minor headmen. In this instance my task was made comparatively easy by the ready co-operation throughout the competition of the Ratemahatmaya and the minor headmen to whom I offer my sincere thanks.

Demonstration Work.—Owing to the interest shown by the small-holders in the competition, demonstration work became easier and gave better results. Very good progress was made in draining, and good drains now exist on a large number of small-holdings in Uda-Palata and Udu-Nuwara. The 'Reverse slope' type is favoured in the majority of holdings, as this type of drain is easy to adopt and is valuable in preventing soil losses from erosion.

The 'Rim-lung' method of pruning has been advocated as most suitable on small-holdings, and many small-holders have readily adopted it. The real benefits to be derived from the adoption of these improved methods can only be fully realised by small-holders when crop is required. At present no material income can be obtained from small-holdings apart from that derived from the sale of tea coupons. Tea coupons are sold independently of the leaf as that is more profitable.

Weather.—Weather conditions during the year have been normal. There was plenty of rain well distributed through the year, and many small-holders lost no time in making use of this opportunity to supply their vacancies and to establish more green manures.

Green Manures.—A large number of small-holders are now aware of the usefulness of growing more green manures in their holdings and how best they can be made use of in the improvement of their tea. Today we find on a good number of small-holdings a good cover of Gliricidias and Dadaps. Gliricidia and Dadap trees are now put to further use in that they act as supports for pepper vines, which afford another source of income. Every opportunity is afforded small-holders in establishing more green manures by the supply of seed and cuttings.

Tea Restriction.—Tea coupons still continue to be sold, as small-holders find it more profitable to do so. Though there has been a sale of coupons, holdings have not been neglected in this district to the extent that is sometimes stated. A good portion of the proceeds realised from the sale of coupons has gone back to the land. Green leaf has been unsaleable without coupons, and this has brought about an enforced rest of the bushes which has done more good than harm to the tea. There are now bigger and better bushes on every holding, especially in those where the rest has been accompanied by other agricultural treatment.

Looking back on the last four years of tea restriction, small-holders will admit that they are in a much better position financially now than

during the few years before restriction. Lending and borrowing facilities which were practically at a standstill before restriction have been made easier. The income derived from the sale of coupons during the last four years has helped small-holders to pay their debts, to improve their holdings, to buy more land, and to become economically sounder.

Bought Leaf Factories.—The bought leaf factory owners have suffered great loss during the last four years of restriction, owing to the saleability of coupons without the produce. They have had to close down their factories as to manufacture uncouponed leaf became unprofitable. This is to be much regretted as they were a great source of help to the small-holders.

Labour.—The bought leaf factory owners employed a large labour force, mostly Sinhalese men and women, as the small-holder's leaf involves a great deal of work. Now that the factories are closed employment is scarce and there is a good deal of hardship amongst this class of labourer.

General.—The period under review has been one of fair prosperity to small-holders. The highest prices for coupons were paid since restriction; the paddy crops harvested during the earlier part of the year were very satisfactory; there was plenty of rain for the cultivation of paddy fields and carrying out improvements on small-holdings; and there were no epidemics to trouble the small-holder. If similar conditions had prevailed during the last three years, small-holdings would be in a better condition than they are today.

The Trinity College Farm was visited in May and demonstrations in pruning and draining were carried out. The members of the College Farmer's Club were present.

It is hoped that if the present conditions prevail, more work and increased progress will be possible in the small-holdings.

R. L. ILLANKOON,
Small-Holdings Officer.

Gampola,
16th February, 1937.

REPORT

OF

THE SMALL-HOLDINGS OFFICER,

BADDEGAMA, FOR 1936.

Rainfall in Baddegama for 1935 ... 117 inches.

,, ,, ,, ,, 1936 ... 107.86 inches.

During the year under review the advisory work in small-holdings was carried out more or less in the same manner as in the previous year.

In order to have correct statistics in my office regarding the small-holdings in the Southern Province, their respective owners and acreage, I prepared a complete register of the small-holdings. The Government Agent, Southern Province very kindly allowed me access to the official small-holdings register at the Galle Kachcheri. A special clerk was engaged for 21 days to transfer all particulars from the official register to the one prepared by me. The number of small-holdings in Galle District amounts to 4,298.

The Southern Province consists of three revenue districts. The Galle District small-holders' register is complete and the preparation of the Matara District small-holders' register will be proceeded with as occasion allows. There are no tea small-holdings in Hambantota District.

Morawak Korale is an important tea-growing area. I paid a three-day visit to the small-holdings there and acquainted the small-holders of the various benefits to be obtained by following as closely as possible the methods advocated by the Tea Research Institute. The general appearances of the small-holdings are more or less the same as in the Galle District.

During 1936 there was a fair demand for tea seed and I was able to obtain two maunds of seed from Nagastenne Group, Dolosbage, for distribution amongst the small-holders. I was also able to assist the small-holders to obtain nursery plants by ascertaining what local nursery had

plants for sale. As a result there has been a good deal of supplying in the holdings.

Small-holders are now beginning to realise the importance of shade trees intergrown with the tea. Several estates kindly supplied Gliricidia cuttings and Grevillea plants free of charge and such gifts were highly appreciated. Our thanks are due to the proprietors of Walpita Group, Kotagoda Estate, Citrus Group and Badungoda Estate for their generosity.

Regular visits were paid during the year to the small-holdings. Six demonstration plots were opened at Keembiya, Baddegama East, Meepawala, Keembi-ela, Akmeemana and Uluwitike. Every month roughly 20 days have been devoted to visiting small-holdings and an average of 60 to 75 small-holdings have been visited each month.

There are two paddy harvesting seasons during the year, namely "Yala" and "Maha", during which season attention to the holdings is partly neglected as every Sinhalese small-holder living in this area has some connection with paddy cultivation either as owner, tenant or lessee. During the harvesting season very often I miss the owners who are away on harvesting work.

Though the Ginganga floods yearly, last year there were no floods to speak of. The weather condition throughout remained even.

During the first half of the year the tea market remained steady at 60 to 62 cents per pound and the coupon market at 48 cents per pound. This allowed a margin for tea apart from its coupon of only 12 to 14 cents per pound and made the disposal of green leaf difficult. Towards the end of the year the tea market rose and the coupon market fell a little which allowed a better margin for green leaf sales which came into fair demand at $2\frac{1}{2}$ to 3 cents per pound. The interest paid by the small-holder to his land varies with the tea and tea coupon markets. With improved conditions more attention was paid to the holdings during the last three months of the year.

On instructions from the Director to organise a competition amongst the small-holders, I consulted the leading planters, officials and the Village Committee Chairmen, all of whom promised to accord any help necessary. An informal conference was held at which it was decided to offer three groups of prizes of Rs. 50, Rs. 30 and Rs. 20 each. It was decided to hold the competition within the first eight months of 1937 and I was requested to take preliminary action by issuing of posters, notices, etc.

During the year I attended three District Agricultural Committee meetings. I also attended four meetings of the Southern Province Planters' Association. On special invitation I addressed a meeting organised by

the members of the Science Society, Richmond College, Galle, on "Methods of Conservation of Soil". Another lecture was delivered by me under the auspices of the Galle District Co-operative Union at St. Aloysius' College Hall on "Improvements to Tea Small-holdings by Methods Advocated by the Tea Research Institute".

In addition to the above, demonstrations in pruning and cutting drains and of soil erosion were given from time to time during my visits to the small-holdings.

E. F. KANNANGARA,

Small-Holdings Officer, Baddegama.

THE TEA RESEARCH INSTITUTE OF CEYLON.

CAPITAL ACCOUNT AS AT 31ST DECEMBER, 1936.

EXPENDITURE

	To 31-12-35 Rs. Cts.	Additions 1936 Rs. Cts.	Deduct Amounts written off Rs. Cts.	Deduct cost of Assets sold or scrapped 1936 Rs. Cts.	Total. Rs. Cts.
To Land Including Development	788,252·42	8,791·72	—	—	797,044·14
,, Buildings and Lines	871,622·35	2,731·68	18,000·00	—	856,354·03
,, Furniture and Equipment	73,495·30	2,004·10	—	707·35	74,792·05
,, Laboratory Equipment	35,293·95	2,276·39	—	152·91	37,417·43
,, Experimental Machinery	20,669·61	4,601·93	—	—	25,271·54
,, Machinery (Estate)	99,950·93	26,485·02	—	14,095·32	112,340·63
,, Motor Car	4,269·00	4,335·00	—	4,269·00	4,335·00
,, Motor Road Roller	—	7,386·03	—	—	7,386·03
Rs.	1,893,553·56	58,611·87	18,000·00	19,224·58	1,914,940·85

RECEIPTS

		Rs. Cts.	Rs. Cts.
By Government of Ceylon :—			
Loan on Mortgage @ 5½% per annum	...	1,000,000·00	
Less : Repayments 31-12-35	Rs. 152,993·38		
Payment in 1936	,, 28,730·36	181,723·74	818,276·26
,, Revenue Applied to Capital Purposes 31-12-36 :—			
To 31st December, 1935	..	967,972·28	
Revenue Account Surplus 1936		61,109·82	
		1,029,082·10	
Less : Transfers from Capital A/c. Lines and Buildings		18,000·00	1,011,082·10
,, Funds Overspent to 31-12-36 :—			
To 31st December, 1935.	...	78,574·66	
During 1936	...	7,007·83	85,582·49
Rs.			1,914,940·85

THE TEA RESEARCH INSTITUTE OF CEYLON.

GENERAL BALANCE SHEET AS AT 31ST DECEMBER, 1936.

LIABILITIES	Rs. Cts.	Rs. Cts.
CREDITORS AND CREDIT BALANCES :—		
Accrued Interest on Loan ...	11,251·30	
Sundry Creditors—Research ...	11,049·18	
Do —Estate ,,	8,977·17	
Subscriptions for Publications received in advance. ...	498·38	
Factory Hygiene Suspense Account	6,120·88	
Motor Road Roller ...	74·36	37,971·27
FURLOUGH RESERVE :—		
At 31st December, 1935 ...	9,876·61	
Add : Reserved during 1936 ...	5,244·00	
	15,120·61	
Deduct : Payments during 1936	5,335·67	9,784·94
DEPRECIATION RESERVE :—		
At 31st December, 1935 ...	222,091·32	
Credited at 31st December, 1936	34,801·33	
	256,892·65	
Less : Amounts transferred to Obsolescence Reserve 11,878·08 Depreciation on Tilting Tray sold 7,310·85	19,188·93	237,703·72
Carried forward		Rs. 285,459·93

ASSETS.		Rs. Cts.	Rs. Cts.
DEBTORS AND DEBIT BALANCES :—			
Controller of Finance and Supply		16,554·25	
Sundries : Research :—			
Ceylon Assn. in London	75·56		
Research Staff	382·63		
E. F. Kannangara (Loan to purchase Car)	300·00		
Sundry Debtors' Account Advertising	702·50		
Accrued Interest on Fixed Deposits.	964·65		
	2,425·34		
Sundries : Estate	1,002·38	3,427·72	19,981·97
STOCK-IN-HAND :—			
Research Tea 20,330 lbs. ...		15,363·34	
Estate—Rice and Sundry Stores 881/65 1,068/-		1,879·65	17,242·99
INVESTMENTS—£2,300-0-0 3½% War Loan		...	32,434·76
Carried forward			Rs. 69,659·72

GENERAL BALANCE SHEET AS AT 31ST DECEMBER, 1936.—(*Contd.*)

LIABILITIES.		Rs. Cts.	Rs. Cts.
Brought forward			285,459·93
OBSOLESCENCE RESERVE :—			
Amount transferred from depreciation reserve.	...	11,878·08	
Less : Items written off :—			
Tilting Tray	6,784·47		
Loss on Car 1936	1,044·00		
Furniture and Office Equipment.	637·35		
Laboratory Equipment	152·91	8,618·73	3,259·35
		Rs.	288,719·28

ASSETS.			Rs. Cts.	Rs. Cts.
Brought forward				69,659·72
CASH :—				
Research :—				
Fixed Deposit		73,839·85		
Current Account		54,324·09		
In Hand		130·84	128,294·78	
Estate :—				
N. B. I. Ltd., Colombo		5,155·48		
In Hand		26·81	5,182·29	133,477·07
FUNDS OVERSPENT :—				
At at 31st December, 1935	...		78,574·66	
Capital Expenditure 1936	...		39,387·29	
Repayment of Loan 1936	...		28,730·36	
			146,692·31	
Less : Revenue applied for capital purposes being revenue account surplus for the year.			61,109·82	85,582·49
				Rs. 288,719·28

We have audited the books of the Tea Research Institute of Ceylon, including those of St. Coombs Estate, for the year ended 31st December, 1936.

The allocations of Capital Expenditure and of Research Revenue Expenditure as made by the Director and sanctioned by the Chairman have been accepted by us.

We are not in a position to say whether the Reserves made for Depreciation are adequate.

Subject to the foregoing reservation, we certify that, to the best of our belief, the above Balance Sheet presents a true and correct view of the financial affairs of the Institute at 31st December, 1936, according to the information and explanations given to us and as shown by the books.

(Sgd.) FORD, RHODES, THORNTON & Co., *Auditors.*
Chartered Accountants.

Colombo, 9th March, 1937.

ESTATE WORKING ACCOUNT FOR THE YEAR ENDED 31ST DECEMBER, 1936.

EXPENDITURE.		Rs. Cts.	INCOME.		Rs. Cts.	Rs. Cts.
To Estate Revenue Expenditure	...	82,771·62	By Tea Sales—Local	153,239 lbs.	121,515·58	
,, Charges—Export Duty, Etc.	...	6,866·26	Do —Factory	996 ,,	699·68	
,, Balance Carried Forward	...	32,910·68	Do —Bro. Mixed	2,222 ,,	333·30	122,548·56
		Rs. 122,548·56				Rs. 122,548·56

REVENUE ACCOUNT AS AT 31ST DECEMBER, 1936.

	Rs. Cts.	Rs. Cts.		Rs. Cts.
To Administration of the Board:—			By Balance from Estate Working Account ...	32,910·68
Planters' Association of Ceylon	1,380·00		,, Tea Cess	305,282·82
Travelling Expenses of Board	4,063·90		,, Interest	3,009·66
Postages ...	101·75		,, Rent of Caddy	50·00
Stationery ...	726·01			
Advertising ...	86·25			
Telephone Trunk Calls and Tele. Address ...	61·23			
Fritning ,,	453·20			
Legal Charges ...	210·00			
Auditors' Fees and Expenses ...	721·04			
Contingencies ...	209·19	8,012·57		
,, Personal Emoluments of Scientific Staff:—				
Director ...	22,500·00			
Mycologist ...	18,000·00			
Agricultural Chemist ...	16,325·34			
Tea Technologist ...	8,631·03			
Entomologist ...	15,637·09			
Plant Physiologist ...	12,709·68	93,803·14		
Carried forward		Rs. 101,815·71	Carried forward	341,253·16

REVENUE ACCOUNT AS AT 31ST DECEMBER, 1936.—(*Contd.*)

	Rs. Cts.	Rs. Cts.
Brought forward		101,815·71
To Emoluments Junior and Sub. Scientific Staff :—		
Junior Scientific Staff ...	27,534·14	
Lab. Attendants and Fieldmen	4,116·10	31,650·24
,, Laboratory :—		
Equipment and General Working Expenses ...	6,860·61	
Furniture ...	171·50	7,032·11
,, Library and Publications :—		
Library ...	1,705·14	
Publications ...	Cr. 1,531·41	173·73
,, Small-Holdings :—		
Salaries and House Allowances	6,069·00	
Travelling and General Expenses	2,873·70	8,942·70
,, Field and Factory Experiments :—		
Agricultural Chemist ...	2,745·21	
Plant Physiologist ...	2,769·51	
Factory Experiments ...	2,958·65	8,473·37
,, Laboratory Offices :—		
Clerks' Salaries ...	5,227·04	
Office Peon ...	528·00	
Stationery and Equipment ...	709·22	
Postages ...	562·68	
Telegrams and Trunk Calls ...	274·71	
Telephone Operators' Salaries	864·00	8,165·65
Carried forward	Rs.	166,253·51

Brought forward	Rs. 341,253·16
Carried forward	Rs. 341,253·16

REVENUE ACCOUNT AS AT 31ST DECEMBER, 1936.—(*Contd.*)

	Rs. Cts.	Rs. Cts.		
Brought forward		166,253·51	Brought forward	Rs. 341,253·16
To Travelling of Staff :—				
Officers' Expenses ...	3,458·80			
Insurance of Car ...	204·03			
Drivers' Wages ..	1,142·74			
Drivers' Batta ...	402·45			
Running Expenses ...	2,337·38	7,545·40		
,, Maintenance of Buildings :—				
Laboratory ...	621·51			
Six Senior Staff Bungalows ...	816·71			
Eleven Junior Staff Bungalows	1,528·88			
Clerks' Bungalows ...	92·60			
Miscellaneous Lines and Buildings	388·75	3,448·48		
,, Items Shared with Estate :—				
Electric Power ...	3,520·67			
Engine Room Staff ...	258·61			
Mechanic ...	653·62			
Telephones Rent and Maintenance	577·56			
Roads ...	604·17			
Sanitation ...	967·74			
Water Supply Maintenance ...	621·26			
Tappal Lorry and Book Fees	216·50			
Laboratory Nethicans ...	334·19	7,754·32		
,, Upkeep of Grounds :—				
Junior and Sub. Staff Surroundings	660·01			
Swamp Reclamation ...	594·39	1,254·40		
Carried forward		Rs. 186,256·11	Carried forward	Rs. 341,253·16

REVENUE ACCOUNT AS AT 31ST DECEMBER, 1936.—(*Contd.*)

	Rs. Cts.	Rs. Cts.		Rs. Cts.
Brought forward		186,256·11	Brought forward	341,253·16
To CONTINGENCIES :—				
Incidentals ...	232·79			
Provident Fund Senior Scientific Staff	4,690·08			
Do Junior Scientific Staff	1,500·50			
Do Clerical & Sub. Staff	599·84			
Passages ...	2,300·00			
Ceylon Nursing Association and Fraser Nursing Home ...	155·00			
Medical Fees Sub. Staff ...	133·37			
Medical Scheme, Junior Staff	999·00			
Insurances ...	1,975·87			
Caretakers and Watchmen ...	269·36			
Dimbula P.A., Compensation Parsonage Bungalow ...	750·00	13,605·81		
,, GOVERNMENT OF CEYLON LOAN INTEREST ACCOUNT		45,131·51		
,, DEPRECIATION ACCOUNT		34,801·33		
,, BAD DEBTS		348·58		
,, BALANCE		61,109·82		
		Rs. 341,253·16		Rs. 341,253·16

LOAN ACCOUNT.

			Rs. Cts.	Rs. Cts.
To GOVERNMENT OF CEYLON ...	... Rs. 1,000,000·00	By REPAYMENTS :—		
		1st Instalment	1929 ... 18,227·00	
		2nd ,,	1930 ... 19,320·72	
		3rd ,,	1931 ... 20,479·00	
		4th ,,	1932 ... 21,708·60	
		5th ,,	1933 ... 23,011·09	
		6th ,,	1934 ... 24,391·74	
		7th ,,	1935 ... 25,855·23	
		8th ,,	1936 ... 28,730·36	181,723·74
		,, Balance	... ...	818,276·26
	Rs. 1,000,000·00			Rs. 1,000,000·00

The Tea Research Institute of Ceylon.

SCIENTIFIC STAFF.

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Field Assistants	...	F. H. Kehl
	...	F. P. Jayawardana
Small-Holdings Officers.	...	R. L. Illankoon
	...	E. F. Kannangara

Superintendent, St. Coombs Estate ... J. A. Rogers

NOTE.

The Laboratories of the Institute are situated at St. Coombs Estate, Talawakelle, and letters and enquiries should be addressed to the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle. Telegraphic Address :—Research, Talawakelle; Telephone, Talawakelle 44 (Private Exchange). It is particularly requested that letters should not be addressed to officers by name.

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